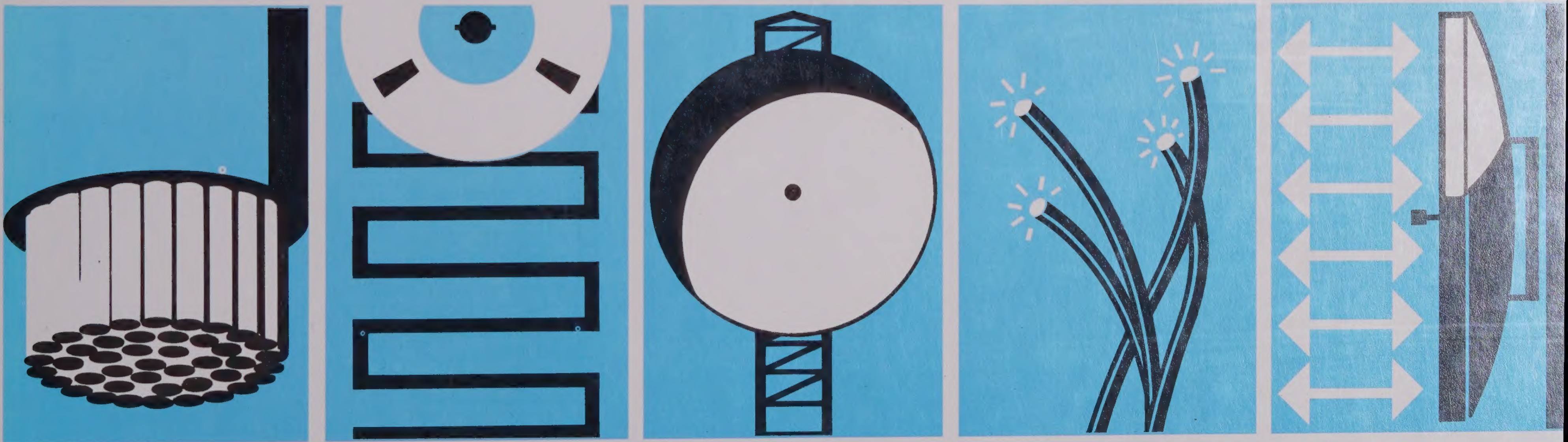
Communications
Transmission Systems

91A



CABLE CARRIER·DATA·MICROWAVE·FIBER OPTICS·MULTIPLEX

TR-911-102(BK1)
Issue 28
January, 1982

GTE LENKURT
INCORPORATED

91A PCM CABLE CARRIER COURSE AND REPEATERED LINE

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TR-911-105
Issue 8
August, 1981

GTE LENKURT
INCORPORATED

91A PCM CABLE CARRIER 9002B & 9004A CHANNEL BANKS, 9104A, 9148A REPEATERED LINE, COURSE CONTENT

I. GENERAL FAMILIARIZATION

Introduction to course.
Discussion to student manual and standard instruction manual.

II. DISCUSSION OF (TDM) DIVISION MULTIPLEXING

(FDM) Frequency Division Multiplexing vs. (TDM) Time Division Multiplexing.
Pulse Code Modulation.
Binary Number System.
Basic Logic Circuits.

III. CHANNEL BANK OPERATION

Block diagram and detailed description of 9002B and 9004A channel bank transmit, receive and alarm functions.

IV. LOOPED CHANNEL BANK ALIGNMENT

Performed using procedures in applicable GTEP's.

V. MULTIPLEXER OPERATION

Block diagram explanation and detailed description of the Transmit, Receive and Alarm Control functions.

VI. MULTIPLEXER OUT-OF-SERVICE PROCEDURES

Performed using the procedure in GTEP 342-911-106.

VII. REPEATERED LINE OPERATION DS1/DS1C

Block diagram explanation and detailed description of the Repeaters and associated equipment.

VIII. REPEATERED LINE EVALUATION TESTS DS1/DS1C

Evaluation tests on the Cable Pair, Repeaters and Repeater Line Operation, and Performance Evaluation. Performed using the procedures in GTEP 342-910-105.

IX. SPARE LINE TRANSFER EQUIPMENT

Detailed description and functional demonstration of Spare Line Transfer equipment.

X. FAULT LOCATING

Comprehensive study of fault locating equipment and practical exercise of its function.

XI. ORDER WIRE

Discussion, utilization, and testing.

XII. END TO END ALIGNMENT OF CHANNEL BANKS

Performed as per applicable GTEP's.

XIII. 9148A MODIFIED DUOBINARY REPEATERED LINE

Block diagram explanation and detailed description of repeaters.

XIV. 9148A MODIFIED DUOBINARY REPEATER EVALUATION TEST

Evaluation test of repeaters using procedures in GTEP 342-910-104.

XV. REVIEW

General discussion.

TR-001-005
Issue 3
January, 1974

STUDENT MANUAL FOREWORD

1. PURPOSE

1.01 This course is intended for supervisory and operations personnel responsible for the installation and maintenance of GTE Lenkurt carrier or radio equipment. Upon satisfactory completion of the training course the participants should be sufficiently familiar with the specific GTE Lenkurt equipment to meet installation and maintenance problems without major difficulty.

1.02 The more intricate details of engineering related to the various equipment items will not be covered in detail; however, sufficient reference will be made to provide a sound basis for further study.

2. STUDENT PREREQUISITES

2.01 Personnel attending this course must have a working knowledge of electronic theory and some practical experience with the maintenance of carrier or radio equipment. Deficiencies in background tend to inhibit learning and devaluate the course for the entire class.

3. STUDENT MANUAL CONTENT

3.01 The Student Manual contains a general outline of the course and supplementary information which is not included in the standard equipment instruction manual shipped with the equipment from the factory. The Student Manual will be used in conjunction with the standard instruction manual material and classroom visual training aids. Various publications normally included in the standard instruction manual are included in the Student Manual for note references and personal use.

3.02 The equipment installed in the classroom is for use by the students in lineup and testing procedures. The Student Manual is keyed to the equipment installed in the classroom. The specifications and drawings contained in the standard instruction manual will be used to provide detailed information on the individual panels and units of the equipment.

GTE LENKURT

TR-001-007
Issue 4
November, 1977

EQUIPMENT IDENTIFICATION AND DOCUMENTATION

I. TERMS AND CODING

1.0 GENERAL

1.1 Descriptive terms and code numbers are assigned to GTE Lenkurt Equipment to provide a ready means of identification and reference. A type number is assigned to each module. The type number can consist of 4 digits and a letter followed by two more digits which identify a particular option of the module. Type numbers can also consist of 5 digits followed by the 2 digit option numbers. The following terms and coding practices are generally used in referring to standard equipment.

2.0 SHELF ASSEMBLY

2.1 The mechanical approach to miniaturization of equipment provides for shelves that extend through the rack and provide the mounting facilities and interconnecting wiring between functional units. Shelf assemblies are identified by type numbers.

3.0 SUBASSEMBLY

3.1 A subassembly is a plug-in or wired-in component which is added to a basic unit chassis or shelf to adapt the basic circuit for a specific application. By the use of subassemblies, one basic chassis may serve in many applications. When wired directly to the shelf wiring, a loop is often provided in the cable to permit extension of the subassembly from the shelf for maintenance and adjustments.

4.0 UNIT

4.1 Circuit components of GTE Lenkurt equipment are assembled in a basic chassis suitable for plug-in mounting on a shelf assembly or on cards which are plugged in the shelf. The basic chassis or card is connected to the electrical circuitry of the shelf assembly by a multiple-pin plug which mates with an appropriate jack at the shelf mounting position. The unit may also have a subassembly. An example is found in the 46200 Group Shelf where the Transmit Summing Amplifiers for redundant application are subassemblies which plug into an attenuator-impedance matching subassembly which plugs into the shelf.

5.0 PANEL

5.1 When circuit components are attached to a mounting base suitable for attachment directly to an equipment rack, the assembly is termed a panel. Generally, a panel has one specific function and performs that function independent of other circuits in a rack assembly. A power filter and fuse panel which provides the voltage for electronic circuits of other equipment is an example. Panels are identified by a four-digit and letter suffix type number (e.g., 5216A), or a five-digit number (e.g., 46820). An additional suffix such as -01 identifies the option arrangement.

6.0 RACK ASSEMBLY

6.1 A rack assembly is an arrangement of equipment mounted on an equipment rack with the intershelf wiring installed. Rack assemblies are identified by the class designator and a five-digit base number which provides cross-reference to the associated descriptive literature and assembly drawings and a two-digit suffix which identifies a specific option.

Example: 46A3 - 46001-03
46A = 46-class multi-channel multiplex system for radio.
3 = Current series of equipment
46001 = Base number key to the Assembly Arrangement options.
-03 = Indicates an option in a specific arrangement.

7.0 SYSTEM

7.1 A system is an arrangement of equipment functioning to provide a communication facility between two or more locations. Sub-system is a general term relating equally to end terminals, repeaters, or other intermediate equipment required to provide the system.

8.0 PUBLICATION NUMBERING SYSTEM

8.1 Many GTE Lenkurt documents utilize the General Telephone and Electronics Practices (GTEP) Section Number System consisting of nine digits such as 342-461-102. The first three digits (Division Numbers) will indicate whether a document is related to Transmission Engineering, Equipment Engineering, or Instructional material. In addition, it will indicate category of equipment; i.e. Carrier, Radio, Data, Test Equipment, etc. Typical GTE Lenkurt Division numbers for major systems are listed in the following table:

EQPT	-ENG	-EE	-I
Carrier	836	819	342
Radio	842	813	394
Data	880	817	350, 556

The second three digits (Sub-division numbers) identify the system, apparatus or sub-divisions of information. Such as 46A (461) Multiplex System, 78A (781) Radio Transmission System.

The final 3 digits (Key Numbers) place the material in specific categories as listed below:

Key Numbers	Assignment
-000 thru -029	General and Administrative
-040 thru -059	Training Material
-070 thru -089*	Engineering Applications
-100 thru -199*	Description of Systems, Equipment and Apparatus
-200 thru -249*	Installation and Removal Methods
-300 thru -349*	Service Maintenance
-400 thru -449	Functional Diagrams and Connecting Information
-500 thru -699*	Alignment Procedures
-800 thru -849	Repair and Modification Procedures

*Most used by Lenkurt

9.0 OPERATION MANUALS

9.1 Operation Manuals (OM's) are GTE Lenkurts latest approach to documenting the information customers require. It uses the GTEP numbering system. The OM provides information for complete assemblies or systems. The Technical Summary lists electrical and mechanical parameters for the assembly. The General Section covers the contents of the OM. The Description Section covers modulation plans and functional operation. Engineering Considerations show typical rack assemblies. Equipment Identification and Ordering Information are contained in tables. Installation Procedures include recommended sequences and assembly wiring tables. Alignment Procedures list test equipment, alignment tests and test point identification. Maintenance covers repair of plug-in units, periodic tests and fault locating.

10.0 DRAWING NUMBERING SYSTEM

10.1 The drawing number is generally prefixed with a two or three letter prefix indicating the type of drawing and some documents have suffixes. Commonly used prefixes and suffixes are:

AA - Assembly Arrangements
AW - Assembly Wiring
BL - Block and Level
BSD - Block Schematic Drawing
EAS - Equipment Assembly and Schematic
-S - Specification Sheet
-AD - Assembly Description

In the following paragraphs detailed information is given in regard to the contents and suggested uses of each of the basic types of drawings.

10.1.1 (AA-) Assembly Arrangements

The Assembly Arrangements drawing provides tables and charts which indicate groups of equipment which may be included in a specific standard rack assembly arrangement. Included in the tables and charts are references to related drawings which detail the circuitry and wiring for each assembly and equipment item. Various notes are used to clarify limitations related to equipment placement, etc.

10.1.2 (AW-) Assembly Wiring

The primary purpose of the Assembly Wiring drawing is to show detailed interconnect wiring required between shelves or panels on an assembly. The AW- is arranged to present all required internal wiring and typical external wiring tie points for the assembly interconnection.

The Assembly Wiring Drawing also contains information such as color code, wire size, treatment of wiring at unequipped ("wired only") positions, permanent strapping and optional strapping. It should be noted that the strapping shown is that which appears on the equipment terminal strip only. The method of determining other strapping information will be discussed in later paragraphs.

10.1.3 (BL-) Block and Level

A Block and Level drawing, as its name implies, consists of functional block drawings of circuits used to accomplish a specific task. Included on the drawing at test points and points of interface are standard and optional levels and impedances. The BL is normally a system level drawing. That is to say that the BL base number is an assembly base number and the drawing shows that entire assembly. Some BL's however, are keyed to an individual shelf within an assembly. In that case the BL's base number will be the type number of the shelf to which it applies.

10.1.4 (BSD) Block Schematic Drawings

Some of the more recently developed GTE Lenkurt equipment types employ the Block Schematic Drawing in place of the BL. The BSD has all of the BL information with added component schematic detail in some areas.

10.1.5 (EAS) Equipment Assembly Schematic

The Equipment Assembly Schematic drawing provides the actual circuit path, component designations and values, jack and pin numbers, terminal or tie point numbering as marked on terminal blocks and plugs. Component pin designation figures are included. Tables listing the various options and strapping requirements are provided. A table of replaceable components is included. The EAS drawing issue number is the issue number marked on the equipment.

10.1.6 (-S) Specification Sheet

The Specification Sheet, or -S is a supplement to the Equipment Assembly Schematic (EAS) for units and uses the unit type number for identification purposes. Its information is keyed to the EAS and includes such things as a technical summary of electrical and physical characteristics of that unit. In addition, the -S also has a description of the electrical operation of the unit keyed to the component designations on the associated EAS. The -S also includes strapping and applications information in some cases.

10.1.7 (-AD) Assembly Description

The Assembly Description, or -AD, is a supplement to the Equipment Assembly Schematic for shelves or panels. It uses the type number of the shelf or panel to which it applies for identification. The types of information on an -AD are identical to the -S.

GTE LENKURT

TR-001-022
Issue 2
January, 1978

SERVICES, PUBLICATION INFORMATION, AND MANUFACTURING CLASSIFICATIONS

1.0 GENERAL

1.1 GTE Lenkurt has the staff and facilities to provide special services to the GTE operating companies and the many other industrial and communications companies utilizing GTE Lenkurt's diversified carrier, data and radio systems and associated support equipment.

2.0 COMPLETE SYSTEM SERVICE

2.1 E.F. & I. (Engineer, Furnish, and Install)

2.1.1 GTE Lenkurt will engineer, furnish and install complete information transmission networks. GTE Lenkurt engineers will (1) perform equipment location and transmission studies, (2) recommend types and quantities of equipment required, and (3) provide detailed drawings, publications, and office records. Based on customer requirements, GTE Lenkurt will furnish all equipment needed including, when necessary, items manufactured by suppliers other than GTE Lenkurt.

2.1.2 Installation crews and construction crews, under the supervision of GTE Lenkurt engineers will construct buildings and towers and will install and align the network. Although the E.F. & I. service can be obtained as a complete package, GTE Lenkurt will provide any part of this service desired. For example, only the equipment engineering needed can be obtained when a network is to be installed in existing offices and is to use existing transmission facilities.

3.0 SPECIAL ENGINEERING & MANUFACTURING

3.1 GTE Lenkurt will perform special system or network applications engineering when requested. This service will provide coordination of overall system layout involving only terminals and repeaters, or coordination of complete communications networks. Instruction material and drawings will be prepared for and keyed to the specific layout required. Circuit layout drawings, wiring drawings, system or network descriptions, and special alignment instructions will be furnished. GTE Lenkurt will procure the required components and assemble the special units and equipment necessary to complete the special system.

4.0 CUSTOMER TRAINING SERVICES

4.1 A customer Training facility is located at the GTE Lenkurt Albuquerque, New Mexico facility and provides comprehensive courses covering carrier and radio products. These courses are intended for supervisory and operations personnel responsible for the installation and maintenance of GTE Lenkurt equipment. The courses provide students with the basic operational principals, knowledge of the documentation associated with the equipment, and familiarity with the test equipment and alignment procedures required to install, turn-up and maintain the GTE Lenkurt equipment.

4.2 Special customer training classes may be arranged on any product or system. The classes may be held at a GTE Lenkurt facility or at the customer's facility. These classes may be oriented to the problems and conditions of the customers special needs as determined by the company representative and GTE Lenkurt engineering staff.

4.3 Further information on special classes or a reservation for one of the standard classes at the customer training facility can be obtained from the GTE Lenkurt sales representative in your area or contact directly with the GTE Lenkurt customer training facility at Albuquerque, New Mexico.

5.0 FACTORY REPAIR SERVICE

5.1 Equipment failures should be corrected by replacing the defective unit with a spare. Defective units should be sent to GTE Lenkurt San Carlos, Attention: Factory Service Department, where the units normally will be repaired and returned within two weeks. If spares are not available and down time is critical, this service can be accelerated or temporary replacement units can be furnished while the defective unit is being repaired (GTE Lenkurt's CARE Program: Customer Accommodation Restoration Equipment). For specific information refer to GTEP 007-005-002.

5.2 GTE Lenkurt guarantees equipment of its manufacture for a period of one year against defective design, material and workmanship, and agrees to remedy any such defect provided that the defective item is delivered intact within one year from date of shipment with transportation prepaid to the GTE Lenkurt factory. This warranty does not extend to tubes, nor to products which have been subject to neglect, misuse, accident, or improper installation, nor to equipment which has been altered by other than authorized GTE Lenkurt personnel. A warranty date code is stamped on each unit prior to shipment.

6.0 DRAWING AND PUBLICATION INFORMATION SERVICE

6.1 The Master Index to Equipment Publications and Drawings is called the SR 330G and is issued quarterly. The master index contains a listing and ordering information for all the currently available drawings, publications and operations manuals available from GTE Lenkurt.

7.0 FIELD SERVICE

7.1 GTE Lenkurt Field Service is available to all customers to quickly solve operating problems. The Field Service Group is staffed with engineers in San Carlos, California and Atlanta, Georgia. This service is available to guarantee that Lenkurt equipment is installed and working correctly. A typical field service problem is received by a telephone call direct from the customer. After discussing the problem with an engineer specialized on the specific equipment concerned, suggestions will be offered to solve the problem. If the problem can not be solved in this manner a field trip may be conducted to resolve the difficulty.

7.2 Field Service is, in most cases, free to the customer. If the trouble is determined to be caused by an obvious lack of maintenance or by local maintenance inexperience, a negotiated cost will be involved.

7.3 On Job Training, (OJT) can be provided on an emergency basis by the Field Service engineer if formal classroom training is not possible.

8.0 MANUFACTURING CLASSIFICATIONS

8.1 Standard

8.1.1 Currently manufactured units and assemblies are generally classified as standard catalog items intended for wide scale use and listed in Operations Manuals (OM), ordering information and price lists. Standard items are expected to be manufactured on a high volume basis and for a long period of time. Associated literature and drawings are kept current. Standard equipment arrangements are engineered to fill the requirements of most customers.

8.2 Special

8.2.1 To handle unusual requirements, special equipment and equipment arrangements are available. Special requirements may be handled on the basis of a specially designed unit or rack assembly, or they may be handled by modification of existing equipment.

8.2.2 GTE Lenkurt can provide special engineering assistance to establish equipment requirements and then provide the special equipment or arrangements.

8.3 Additions and Maintenance Only

8.3.1 When a product has been superseded by later equipment, it will be classed for Additions and Maintenance Only. In this case only customers who already have the equipment may order for additions to existing equipment or for maintenance spares. Price and delivery are normally affected. This classification is referred to as A & M.

8.4 Manufacture Discontinued

8.4.1 When there is no longer sufficient demand for an equipment item, it will be classed Manufacture Discontinued, which makes the item unavailable. Usually this classification follows a period of A & M.

9.0 EQUIPMENT CHANGES

9.1 General

9.1.1 GTE Lenkurt equipment is identified by a label, foilcal, engraving or stamping on the unit which lists the type, option, model and issue number. Also a descriptive title is generally included. Basic type and option numbers are assigned at the time equipment is first placed into production. Subsequent changes are identified in various ways depending on the complexity of the change.

9.1.2 When changes are sufficiently extensive to possibly affect interchangeability, a change will be made in the model number. If the changes are of a minor nature only the issue number will be changed.

9.2 The most common two types of changes to existing equipment are:

9.2.1 Issue Change

The issue number relates to the issue of the EAS drawing that is associated with the equipment and indicates that all changes up to and including that issue number have been incorporated in the circuitry or mechanics of the item. Only minor changes are involved in an issue change, such as change in the value of a resistor or capacitor. An issue change will normally not affect interchangeability of similar model and type-numbered equipment, although performance may be improved.

9.2.2 Model Number

A change in model number may affect interchangeability of equipment. Equipment with a later model number is capable of greater application or is more effective in performance of its function than earlier models. A later model may usually be substituted for an earlier model providing the type number is unchanged. An earlier model cannot be used in all applications of a later model. When a model change is effected, the basic drawings are redrawn and brought up to date. Where more than one model of the same type number exists in the office, the last issue change of the preceding model drawings and the latest issue change of the current model should be retained.

9.3 Modifications Kits are made available when units in the field need to be updated and the change can be made without affecting the factory tuning of the unit. These Mod. Kits are generally made available for free for a period of two years and after that for a nominal fee. The announcement of the availability of a Mod. Kit and the reason for the updating is done by Engineering Letter. The Mod. Kit includes all parts, a decal, unit drawing, and directions for accomplishing the updating.

9.4 If questions exist regarding the interchangeability of specific models or issues of equipment, refer to available documentation or contact your nearest GTE Lenkurt Field Service office.

10.0 ADDITIONAL INFORMATION

10.1 EL - Equipment List - Equipment rackmounted by GTE Lenkurt will be accompanied by an Equipment List itemizing everything that is included in the rack. It is placed in front of the instruction manual that accompanies the rack. This list should be retained in the office file for future reference.

10.2. EL - Engineering Letter - These letters are issued to inform customers of engineering type information. They are issued as required.

Handling Considerations for Electrostatic Discharge Sensitive Equipment

1. GENERAL

1.01 This Section provides information on field handling of electrostatic discharge sensitive (ESDS) equipment. For detailed repair procedures for ESDS units, refer to Section 300-910-300.

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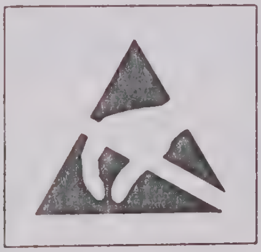
2. HANDLING CONSIDERATIONS

General

2.01 Personnel can generate an enormous static electrical charge on their bodies through normal, routine activities. If not properly discharged before handling equipment, this charge can degrade or destroy ESDS devices by the touch of a finger to any part of a unit containing such a device. GTE Lenkurt is identifying ESDS equipment by coloring the front edge of printed wiring boards red. Also, printed wiring boards, units with face plates, completely enclosed units, and their shipping containers are identified with the EIA symbol for ESDS devices. See figure 1.

Figure 1. EIA
ESDS Symbol



2.02 To avoid damage when unpacking, installing, testing, or otherwise handling ESDS equipment, observe the precautions detailed in the following paragraphs.

Grounding Practices

2.03 To avoid damage to ESDS devices during handling, observe the following minimum rules:

(a) Keep workers at a ground potential with conductive wrist straps connected to ground. The wrist strap must be in contact with the bare wrist.

WARNING: The wrist strap ground must include a one to two megohm resistor in series with the ground lead. This prevents a hard ground which could allow a hazardous current to flow through the worker in the event of accidental contact with a hazardous voltage.

(b) Keep the work station at ground potential by using approved conductive bench covers and floor mats.

(c) Ground all electrical equipment at the work station (e.g., soldering irons, test equipment, etc). Soldering irons should be isolated from ac source, with tip grounded to work station.

(d) Use only uninsulated hand tools (e.g., pliers, cutters, etc) and place them on a grounded surface when not in use.

(e) Use protective containers to store or transfer ESDS units. Protective containers are special conductive plastic bags, metal boxes, or conductive foam enclosures. The shipping boxes are safe containers for this purpose.

(f) Wear close fitting, sleeveless, or short sleeve garments while handling ESDS units. If long sleeves are worn, antistatic sleeve protectors must be banded to the bare wrists.

(g) Never permit an ESDS unit to contact clothing, textiles, ordinary plastic items, or ungrounded skin. These are the main sources of static charges.

(h) Avoid touching ESDS unit connector pins or printed wiring boards to a hard ground.

Unpacking and Installing Equipment

2.04 ESDS equipment is shipped from GTE Lenkurt in the proper containers to protect against ESD damage during shipment. To preserve this protection, observe the following rules:

(a) Do not remove the individual units from the shipping boxes until they are to be installed in the equipment shelves. Ensure that storage area meets all fire code requirements.

(b) Before removing units from their shipping boxes, attach the grounded wrist strap and place the box on a grounded work surface or against the grounded equipment chassis to remove the static charge on the outer surface of the container. It is preferable to perform this task at the equipment location and to immediately insert the unit in its proper location in the equipment shelf.

(c) If any strapping operations are required on an ESDS unit, take the unit in its shipping container to a properly grounded work station and install the straps, observing all the general grounding practices cited in paragraph 2.03. Return the unit to its container for transport back to the equipment location. In lieu of the shipping container, the unit may be transported around the site in a special conductive plastic bag.

(d) To install a unit in its equipment shelf, attach the wrist strap to the bare wrist and to the equipment ground point, ground the box as instructed in step (b), remove the unit from the box or plastic bag and insert it in its place in the shelf.

Testing Considerations

2.05 Even when installed in a shelf it is possible for ESDS units to be damaged by static discharges through certain paths. When used, face plates are connected to ground; however, some other components such as LED indicators may provide a discharge path.

(a) Attach the wrist strap before beginning tests or alignment procedures.

(b) Ground the chassis of all test equipment to the equipment ground point. If the test equipment is in a plastic case, place it on or against a grounded surface.

Removing Equipment

2.06 Similar rules must be observed when removing an ESDS unit from an equipment shelf.

(a) Attach the wrist strap before touching equipment.

(b) Remove the unit and place it in a protective container.

(c) If the unit is to be returned to GTE Lenkurt for repair, it may be placed directly in the shipping box in which it was received; however, that box must be placed on a grounded surface before inserting the unit in the box.

Special Situations

2.07 If a wrist strap and protective containers are not available, less desirable but moderately effective procedures can be employed as follows:

(a) When installing a unit in a shelf or work station, place one hand on a ground point of the equipment assembly or rack, then with the other hand install the unit.

(b) The same procedure must be followed when removing the unit from a shelf.

(c) Do not allow the unit to contact anything until it is placed in a protective container.

(d) If the special protective containers are not available, the unit may be transported by the person who removed it from the shelf or work station, provided the unit is not allowed to touch anything or anybody during transport. When arriving at the destination the grounding procedure described at the beginning of this paragraph must be observed.

Unit Repair

2.08 Repair of units in the field is not generally recommended. The defective units should be returned to GTE Lenkurt for repair (see paragraph 2.06(c). If the user wishes to establish his own repair facility the general grounding practices (paragraph 2.03) should be strictly observed. For detailed repair procedures for ESDS units refer to Section 300-910-300.

GTE Practices
Engineering—Plant Series
GTE LENKURT

Test Cords, Plugs, and Adapter Assemblies

1. GENERAL

1.01 This Section lists the GTE Lenkurt standard plugs, adapters and cords available for patching, testing or maintenance of GTE Lenkurt carrier, telegraph, test, or radio equipment.

▶1.02 Issue 10 of this Section adds new items indicated by revision arrows. Remove the previous issue of this Section from the binder or microfiche file and replace it with this issue. ◀

2. DESCRIPTION

2.01 All items are listed in numerical order in separate sections; each is shown in pictorial and schematic form. A brief description and typical use are included.

2.02 The telephone type double plugs have a serrated side for polarity indication, usually called the "Tip" side of the plug. The non-serrated side is designated as the "Ring" side.

3. INDEXING

3.01 Both numerical and descriptive indexes are provided. The numerical index, figure 1, lists plugs, adapters or cords by the assigned GTE Lenkurt number.

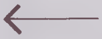
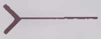
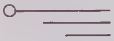
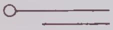
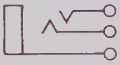
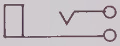
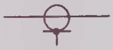
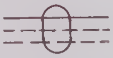
3.02 When the typical characteristics of the desired plug, adapter or cord are known, the Descriptive Index of figure 2 may be used to determine the GTE Lenkurt number and the page number where the item is described.

4. LEGEND

4.01 The following symbols are used to distinguish the diameters of the telephone type and telephone coaxial plugs, single and dual (typical WECo equivalents are also indicated):

○	Standard (NORMAL) telephone; 0.250-inch nominal diameter (6.350 mm) TRS: WECo equiv. 310 (sgl); 338 (dbl) TS: WECo equiv. 347 (sgl); 241 (dbl)
●	Standard (SMALL) telephone; 0.210-inch nominal diameter (5.334 mm) TRS: WECo equiv. 309 (sgl)
Ⓜ	Miniature telephone; TS or TRS; 0.173-inch nominal diameter (4.394 mm)
□	Standard coax; 0.375-inch nominal diameter (9.525 mm) WECo equiv. 358 (sgl); 372 (dbl)
🄼	Miniature coax; 0.297-inch nominal diameter (7.541 mm) WECo equiv. 440 (sgl); 443 (dbl)

4.02 The following schematic symbols are used to distinguish the items on the following pages:

	Male coaxial, pin prod or banana.
	Female coaxial, pin prod or banana.
	T-R-S plug, standard or miniature series.
	T-S plug, standard or miniature series.
	T-R-S jack, standard or miniature series.
	T-S jack, standard or miniature series.
	Coaxial lead(s).
	Shielded lead(s).

4.03 Whether the fitting(s) is male or female is determined by the center conductor(s) and not the shell of the fitting(s).

Figure 1. Numerical Index — Cords, Plugs, and Adapters (Sheet 1 of 2)

Number	Page
583B	22
583C	22
583D	22
583E	22
613A	11
614A	11
616B	7
616C	7
621A	11
625A	11
627A	11
631A	11
632A	11
632B	11
632C	11
633A	11
633B	11
636A	19
641A	11
646A	12
646B	12
647A	15
648A	17
649A	19
650A	19
651A	15
651B	19
651C	15
661A	17
662A	12
663A	12
664A	12
665A	7
665B	7
666A	7
666B	7
668A	7
669A	7
670A	7
670B	7
673A	16
674A	15
674B	15
674C	15
676A	7
676C	7
676D	8
683A	20
684A	12
684B	15
684D	15
684G	20
691A	8
693A	16
693B	18
695A	15
696A	7
699A	12
700A	18
701A	9
703A	18
708A	9
708B	9
708C	10
709A	10
711A	10
712A	12
713A	16
714A	19
714B	19
716A	19
717A	10
719A	19
720A	10
721A	18
721B	18
721C	18
722A	12
723A	12
724A	13
725A	13
727A	13
728A	18
729A	13
729B	13
731A	7
732A	18
732B	18
732C	18
733A	7
733B	7
733C	7
735B	7
738A	8
738B	8
738C	8
741A	13
741B	13
743A	18
744A	16
745A	10
746A	10
746B	11
750A	10
751A	10
751B	10
753A	16
754A	16
760A	22
774A	18
789A	11
790A	18
790B	18
791A	9
791B	9
792A	9
793A	8
794A	8
796A	20
798A	9
799A	9
28470	8
44880	10
44892	20
44893	21
44894	21
48527	21
51994	8
52040	9
6000A	7
6000F	11
6000H	9
6012A	16
6014A	16
6015A	20
6015B	20

Figure 1. Numerical Index — Cords, Plugs, and Adapters (Sheet 2 of 2)

Number	Page
6025A	20
6025B	13
6046A	16
6046B	17
6046C	17
6046D	17
6046E	7
6046F	8
6046G	8
6046H	17
6046J	16
6046K	17
6046L	17
6046M	17
6049A	11
6058A	8
6100B	13
6100C	13
6100D	13
6100E	13
6100F	14
6100G	14
6100J	14
6100K	14
6100L	14
6126A	14
6127A	14
6128A	14
6128B	15
6129A	15

Figure 2. Descriptive Index — Cords, Plugs, and Adapters (Sheet 1 of 4)

Contents	Number	Page
TERMINATING PLUGS		
Telephone Type Plugs:		
Double TS plug e/w 130-ohm resistor wired tip-to-tip	616B	7
Double TS plug e/w 600-ohm resistor wired tip-to-tip	616C	7
TRS plug e/w 130-ohm resistor wired tip-to-ring	665A	7
TRS plug e/w 100-ohm resistor wired tip-to-ring	665B	7
TRS plug e/w 600-ohm resistor wired tip-to-ring	666A	7
TRS plug e/w 900-ohm resistor wired tip-to-ring	666B	7
TRS plug e/w 2610-ohm resistor wired tip-to-sleeve	668A	7
Miniature TRS plug e/w 600-ohm resistor	6000A-01	7
Miniature TRS plug e/w 900-ohm resistor	6000A-02	7
Miniature TRS plug e/w 135-ohm resistor	6000A-03	7
Miniature TRS plug open	6000A-04	7
Twin Banana Plugs:		
Twin banana plug e/w 130-ohm resistor	669A	7
Twin banana plug e/w 600-ohm resistor	670A	7
Twin banana plug e/w 900-ohm resistor	670B	7
Twin banana plug e/w 75-ohm resistor	696A	7
Coaxial Type Plugs:		
Male coax plug e/w 75-ohm resistor and test pin jack	676A	7
Male coax plug e/w 75-ohm resistor	676C	7
Subminiature threaded female coax plug e/w 75-ohm resistor	731A	7
Coaxial Type Plugs: (Cont'd)		
BNC plug e/w 75-ohm resistor	733A	7
BNC plug e/w 600-ohm resistor	733B	7
BNC plug e/w 61.9-ohm resistor	733C	7
Subminiature push-on female coax plug e/w 75-ohm resistor	735B	7
Double male coax plug e/w 124-ohm resistor	793A	8
Miniature coax plug e/w 75-ohm resistor	6046E	7
Twin miniature coax plug e/w 124-ohm resistor	6046F	8
Double subminiature coax plug e/w 130-ohm resistor	28470	8
Twin Connector Uhf Type Plugs:		
Male twin conductor plug e/w 124-ohm resistor	6058A	8
OPEN, LOOP, AND ATTENUATOR PLUGS		
Coaxial Type Plugs:		
Double male coax plug, hairpin	676D	8
BNC to BNC coax connector, UG-914/U	691A	8
SMA connector e/w 3.0-dB attenuator	738A	8
SMA connector e/w 10.0-dB attenuator	738B	8
SMA connector e/w 20.0-dB attenuator	738C	8
Three-way signal splitter, BNC receptacle on each leg	794A	8
Two miniature female coax connectors used as a looping plug	6046G	8
75-ohm, 2-dB looping plug attenuator	51994-02	8
75-ohm, 3-dB looping plug attenuator	51994-03	8
75-ohm, 4-dB looping plug attenuator	51994-04	8
75-ohm, 5-dB looping plug attenuator	51994-05	8

Figure 2. Descriptive Index — Cords, Plugs, and Adapters (Sheet 2 of 4)

Contents	Number	Page
Coaxial Type Plugs: (Cont'd)		
75-ohm, 6-dB looping plug attenuator	51994-06	8
75-ohm, 12-dB looping plug attenuator	51994-12	8
Special Purpose Plugs:		
Double 18-pin male connectors e/w strapping for LN repeater loop-back testing	52040	9
ADAPTERS		
Telephone Type Adapters:		
TRS male standard to female miniature	6000H-01	9
TS male standard to female miniature	6000H-02	9
TS female miniature both ends	6000H-03	9
TRS female miniature both ends	6000H-04	9
TRS female standard to miniature	6000H-05	9
TS female standard both ends	6000H-06	9
TRS female standard both ends	6000H-07	9
N Type Adapters:		
N female to SMA male coax	791A	9
▶ N female to SMA female	791B ◀	9
N male to SMA male coax	792A	9
▶ SMA Type Adapters:		
Male SMA to female SMA	798A	9
Right angle male SMA to female SMA	799A ◀	9
BNC Type Adapters:		
BNC female to subminiature female coax	701A	9
BNC male to twin binding posts	708A	9
BNC female to male banana plug	708B	9
▶ BNC female to male double banana plug	708C ◀	10
BNC female to subminiature male coax	711A	10
BNC female to twin subminiature male, e/w 75-ohm resistor	717A	10
BNC female to male uhf coax; conforms to MIL-UG-273/U	745A	10
BNC female to male micro-miniature plug	746A	10
BNC tee adapter; conforms to MIL-UG-274/U	750A	10
BNC male to N female; conforms to MIL-349/U	751A	10
BNC female to N male coax; conforms to MIL-201A/U	751B	10
Adapter Kit:		
Adapter set e/w four coax adapters, usable with standard test cords for 75-class testing	44880	10

Contents	Number	Page
Coaxial Type Adapters:		
Twin subminiature female coax both ends	709A	10
Female twin conductor uhf-type to double male subminiature coax	720A	10
Female standard coax to female subminiature coax	746B	11
Male coaxial connector to female BNC	789A	11
Female twin conductor uhf-type at both ends	6000F	11
Female uhf-type twin conductor to double male miniature coax	6049A	11
TEST CORDS AND SERVICE EXTENSION CABLES		
Test Cords with Telephone Type Plugs:		
Double TS plug each end, wired tip-to-tip (3 feet)	613A	11
Double TS plug each end, wired tip-to-tip (6 feet)	614A	11
Single TS plug each end, wired tip-to-tip (1 foot)	621A	11
Single TS plug each end, wired tip-to-tip (6 feet)	625A	11
Single TS plug each end, wired tip-to-tip (3 feet)	631A	11
Double TS plug to single TS plug, wired tip-to-tip and tip-to-sleeve (6 feet)	627A	11
Single TRS plug each end, wired tip-to-tip, ring-to-ring, and sleeve-to-sleeve (6 feet)	632A	11
(9 feet)	632B	11
(15 feet)	632C	11
Single TRS plug each end, wired tip-to-tip, ring-to-ring, and shield-to-sleeves (6 feet)	633A	11
(15 feet)	633B	11
Double TS plug each end, wired tip-to-tip and shield-to-sleeves (6 feet)	641A	11
Double TS plug to twin banana plug, wired shield-to-sleeves (6 feet)	646A	12
(10 feet)	646B	12
Double TS plug to single TRS plug, wired tip-to-tip, tip-to-ring, and shield-to-sleeves (6 feet)	662A	12
Single TRS plug to 2 crocodile clips, wired shield-to-sleeve (6 feet)	663A	12
Single TRS plug to twin banana plug, wired shield-to-sleeve (6 feet)	664A	12
Double TS plug to twin pin plug wired tips to twin pin plug and shield-to-sleeve of TS plug (9 feet)	684A	12
Single TRS plug to twin banana plug wired tip-ring only (6 feet)	699A	12
Single TRS plug to UG-260/U coax connector, wired tip-ring only (6 feet)	712A	12

Figure 2. Descriptive Index — Cords, Plugs, and Adapters (Sheet 3 of 4)

Contents	Number	Page
Test Cords with Telephone Type Plugs: (Cont'd)		
TRS plugs (2) to 6-point test plug (15 feet)	722A	12
Single TRS plug to 2 alligator clips, low resistance wire for use as power cord, tip-sleeve only (12 feet)	723A	12
Single TRS plug to 4-point butt-in plug (12 feet)	724A	13
Single TRS plug each end, low resistance wire for use as power cord, wired tip-to-tip and sleeve-to-sleeve (12 feet)	725A	13
Single TS plug to twin banana plug (6 feet)	727A	13
Single TRS plug to twin pin plug tip-ring only (8.5 feet)	729A	13
Miniature TRS plug to twin pin plug shielded cable (8 feet)	729B	13
Double TRS plug each end, wired tip-to-tip, ring-to-ring, and sleeve-to-sleeve (3 feet)	741A	13
(6 feet)	741B	13
Miniature TS plug to standard TS plug (6 feet)	6025B	13
Miniature TRS plug to twin banana plug, shielded 2-conductor cord		
(5 feet)	6100B-01	13
(10 feet)	6100B-02	13
Miniature TRS plug each end, shielded 2-conductor cord		
(5 feet)	6100C-01	13
(10 feet)	6100C-02	13
(3 feet)	6100C-03	13
(2.5 feet)	6100C-04	13
Miniature TRS plug to standard TRS plug, shielded 2-conductor cord		
(5 feet)	6100D-01	13
(10 feet)	6100D-02	13
Miniature TS plug to single banana plugs, single conductor shielded cord (5 feet)	6100E	13
Double TS plug to single TRS miniature plug, wired tip-to-tip, tip-to-ring, and sleeve-to-sleeve (6 feet)	6100F	14
Double miniature TRS both ends		
(2 feet)	6100G-01	14
(3 feet)	6100G-02	14
(6 feet)	6100G-03	14
(10 feet)	6100G-04	14
Miniature TRS plug to crocodile clips (6 feet)	6100J	14
Standard TRS plug to miniature TRS plug and twin pin plug (8 feet)	6100K	14
Standard TRS plug to miniature TRS plug (10 feet)	6100L	14
Miniature TRS plug at each end		
(6 feet)	6126A-01	14
(10 feet)	6126A-02	14
(15 feet)	6126A-03	14
Double miniature TRS plug at each end		
(6 feet)	6127A-01	14
(10 feet)	6127A-02	14
(15 feet)	6127A-03	14
Double miniature TRS plug to double standard TRS plug		
(6 feet)	6128A-01	14
(10 feet)	6128A-02	14

Contents	Number	Page
Test Cords with Telephone Type Plugs: (Cont'd)		
Double miniature TRS plug to double small (.206) TRS plug		
(6 feet)	6128B-01	15
(10 feet)	6128B-02	15
Miniature TS plug at each end		
(6 feet)	6129A-01	15
(10 feet)	6129A-02	15
Test Cords with Twin Banana Plugs:		
Unshielded twin banana plug to alligator clips (6 feet)	647A	15
Unshielded twin banana plug to test prods (6 feet)	651A	15
Unshielded twin banana plug to test prod and clip (6 feet)	651C	15
Unshielded twin banana plug to coaxial plug (6 feet)	674A	15
Unshielded twin banana plug to small pin prods (6 feet)	674B	15
Unshielded twin banana plug to coaxial connector (6 feet)	674C	15
Unshielded twin banana plug to twin pin jack plug; shield to banana plug (8.5 feet)	684B	15
Unshielded twin banana plug each end (3 feet)	684D	15
Shielded twin banana plug, coaxial cord (1.5 feet)	695A	15
Unshielded twin banana plug to insulated alligator clips (4 feet)	6012A	16
Unshielded twin banana plug to small pin prods, standard red and black test lead wire (4 feet)	6014A	16
Twin banana plug to twin pin plugs; 75-ohm coax (6 feet)	6046J	16
Test Cords with Coaxial Type Plugs:		
Male coax plugs each end (2 feet)	673A	16
Male coax plug to BNC connector (6 feet)	693A	16
Twin coaxial to twin banana plug (6 feet)	713A	16
Male "coaxial insert" plug each end (4 in.)	744A	16
Male standard coax plug to 2 alligator clips (6 feet)	753A	16
Double male standard coax plug to 3 alligator clips (6 feet)	754A	16
Miniature coax plug to male BNC connector (6 feet)	6046A	16
Miniature double coax plug to twin banana plug and grounded single banana plug (6 feet)	6046B	17
Miniature male coax plug each end		
(2 feet)	6046C-01	17
(6 feet)	6046C-02	17
(10 feet)	6046C-03	17
(.5 feet)	6046C-04	17
(1 foot)	6046C-05	17
(1.5 feet)	6046C-06	17
(2.5 feet)	6046C-07	17
Double male coax plug each end		
(2 feet)	6046D-01	17
(6 feet)	6046D-02	17
(10 feet)	6046D-03	17

Figure 2. Descriptive Index — Cords, Plugs, and Adapters (Sheet 4 of 4)

Test Cords with Coaxial Type Plugs: (Cont'd)

Contents	Number	Page
Miniature double coax plug to male twin conductor, uhf-type connector; shielded pair test cord (6 feet)	6046H	17
Double male standard coax plug to double male miniature coax plug		
(6 feet)	6046K-01	17
(10 feet)	6046K-02	17
Single miniature TRS plug to standard double male coax plug (6 feet)	6046L-01	17
(10 feet)	6046L-02	17
Double male miniature coax plug to twin pin plug	6046M	17

Test Cords with Coaxial Type Connectors:

Contents	Number	Page
Male UG-88/U coax connector both ends (6 feet)	648A	17
Male coax N connectors, both ends (6 feet)	661A	17
BNC coax connector to alligator clips (6 feet)	693B	18
Subminiature coax connector, both ends (1.5 feet)	700A	18
Subminiature coax connector, both ends; balanced 130-ohm test cord (7 feet)	703A	18
BNC to BNC; RG-59/U coax cable		
(1.5 feet)	721A	18
(3 feet)	721B	18
(6 feet)	721C	18
Twin coaxial to twin subminiature (6 feet)	728A	18
Subminiature male to male coax connectors; RG-187/U (3 feet)	732A	18
Subminiature female to female coax connectors; RG-187/U (3 feet)	732B	18
Subminiature male to female coax connectors; RG-187/U (3 feet)	732C	18
Subminiature snap-on female coax connector each end (4 in.)	743A	18
▶ BNC connector to female Berg MINI PV connector; RG-187/U (1.25 feet)	774A ◀	18
Female coax connector, both ends; RG-371 (1 foot)	790A	18
Female coax connector, both ends; RG-371 (10 feet)	790B	18

Test Cords with Twin Conductor Uhf Type Connectors:

Contents	Number	Page
Male twin conductor, uhf-type connector to twin banana plug (6 feet)	714A	19
Female twin conductor, uhf-type connector to 3 alligator clips (6 feet)	714B	19
Male twin conductor, uhf-type connector to subminiature twin female (1.5 feet)	716A	19
Two conductor coaxial plug to twin conductor uhf-type male plug (6 feet)	719A	19

Special Purpose Test Cords and Service Extension Cables

Contents	Number	Page
Single pin prod both ends (1 foot)	636A	19
11-pin male to 20-pin female test cord for patching test sets to 45-class vf and signaling circuits (9 feet)	649A	19
20-pin male to 20-pin female test cord; patches test sets to 45-class hf circuits or extends units when used with 655A or 671A (9 feet)	650A	19
Standard test prods, red and black, to single banana plugs (3 feet)	651B	19
20-pin male to 20-pin female test cord; patches 681B repeater switching set (9 feet)	683A	20
▶ 12-pin male to 12-pin male test cord; patches test sets to 9004A PCM Channel Bank (6 feet)	796A-01	20
(12 feet)	796A-02 ◀	20
Twin pin jack plugs both ends (2 feet)	684G	20
Single pin black prod both ends (2 feet)	6015A	20
Single pin red prod both ends (2 feet)	6015B	20
Pin test probes to TS plug (6 feet)	6025A	20
Service extension cable; extends 37491 or 37492 from shelf (4 feet)	44892	20
Service extension cable; extends 37493 or 37496 from shelf (4 feet)	44893	21
Service extension cable; extends 37494 or 37495 from shelf (4 feet)	44894	21
Male 10-pin, 3-coaxial connector to female 10-pin, 3-coaxial connector; extends 778 plug-in units from shelf (6 feet)	48527	21

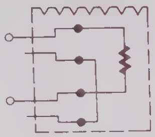
Test Transformers:

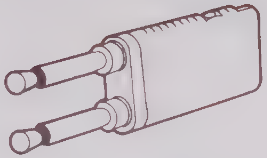
Contents	Number	Page
Transformer, 600-ohm unbalanced impedance (banana plug) to 130-ohm or 600-ohm balanced impedance (binding posts)	583B	22
Transformer, 600-ohm unbalanced impedance (banana plug) to 600-ohm or 900-ohm balanced impedance (binding posts)	583C	22
Transformer, 600-ohm unbalanced impedance (banana plug) to 130-ohm balanced impedance (binding posts)	583D	22
Transformer, 600-ohm unbalanced impedance (banana plug) to 75-ohm impedance (coaxial BNC jack)	583E	22
Transformer, impedance matching test set to match 75-ohm coaxial plug to 124-ohm twin uhf connection	760A	22

TERMINATING PLUGS

Telephone Type Plugs

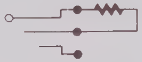
Type	Description
616B Plug ○	130-ohm terminating plug for double TS jacks.
616C Plug ○	600-ohm terminating plug for double TS jacks.

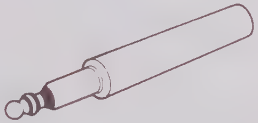




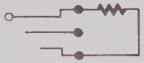
Type	Description
665A Plug ○	130-ohm terminating plug for single TRS jacks.
665B Plug ○	100-ohm terminating plug for single TRS jacks.
666A Plug	600-ohm terminating plug for single TRS jacks
666B Plug ○	900-ohm terminating plug for single TRS jacks.
6000A-XX Plug Ⓜ	Single miniature TRS terminating plug.

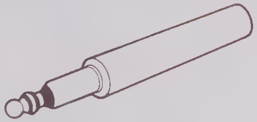
XX	RESIST.
01	600
02	900
03	135
04	OPEN





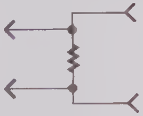
Type	Description
668A Plug ○	2610-ohm plug with terminating resistor connected across tip-sleeve. For single TRS jacks in 91-Class equipment.

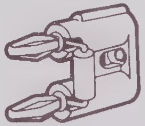




Twin Banana Plugs

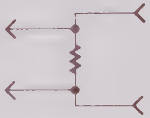
Type	Description
669A Plug	130-ohm twin banana plug for terminating ACVM or other test equipment.
670A Plug	600-ohm twin banana plug for terminating ACVM or other test equipment.

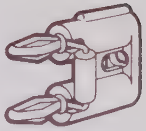




Twin Banana Plugs

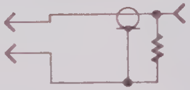
Type	Description
670B Plug	900-ohm twin banana plug for terminating ACVM or other test equipment.
696A Plug	75-ohm twin banana plug for terminating ACVM or other test equipment.

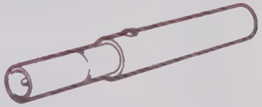




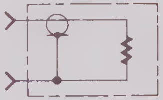
Coaxial Type Plugs

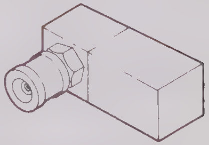
Type	Description
676A Plug ☐	75-ohm terminating plug for standard coaxial jacks. Includes a test pin jack.
676C Plug ☐	75-ohm terminating plug for standard coaxial jacks
6046E Plug 🄼	Single miniature telephone coaxial plug for terminating 75-ohm circuits



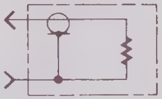


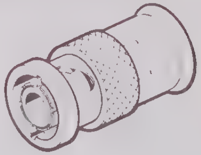
Type	Description
731A Plug	75-ohm terminating plug. Equipped with female threaded connector. Used to terminate 75-Class equipment.



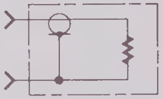


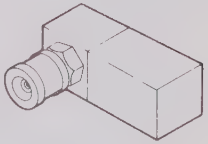
Type	Description
733A Plug	75-ohm male BNC terminating plug.
733B Plug	600-ohm male BNC terminating plug.
733C Plug	61.9-ohm male BNC terminating plug.



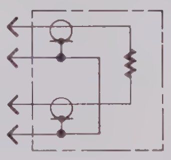
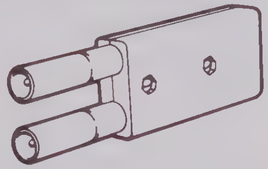
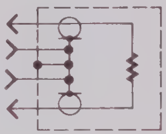
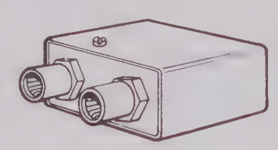


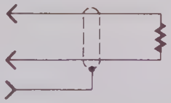
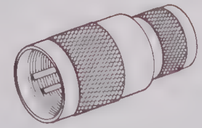
Type	Description
735B Plug	75-ohm terminating plug. Equipped with subminiature push-on connector.



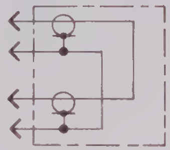
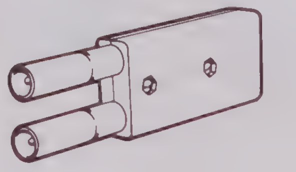
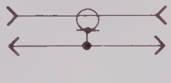
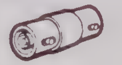


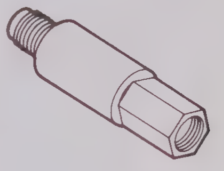
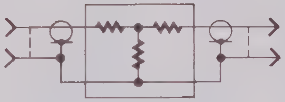
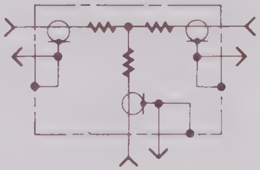
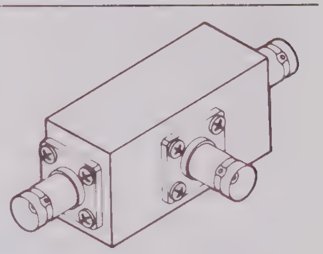
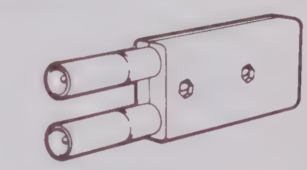
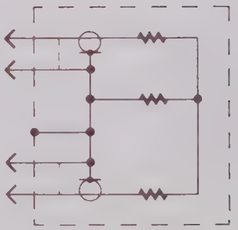
TERMINATING PLUGS (Cont'd)

Type	Description	Coaxial Type Plugs
793A Plug ☐	124-ohm terminating plug for double coaxial jack.	 
6046F Plug M	Twin miniature telephone coaxial plug for terminating 124-ohm circuits.	
28470 Plug	130-ohm terminating plug with two male subminiature coaxial connectors.	 

Type	Description	Twin Contact UHF Type Plugs
6058A Plug	Male uhf-type twin connector plug for terminating 124-ohm circuits.	 

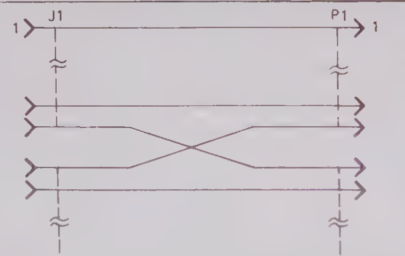
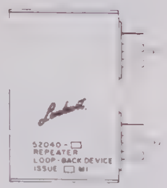
OPEN, LOOP, AND ATTENUATOR PLUGS

Type	Description	Coaxial Type Plugs
676D Plug ☐	Looping plug for connecting two telephone coaxial jacks in tandem.	 
6046G Plug M	Looping plug with circuit connected between two female miniature coaxial connectors.	
691A Plug	BNC coaxial connector plug. Female ends provided for connecting two test cords with BNC fittings. (UG-914/U)	 

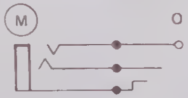
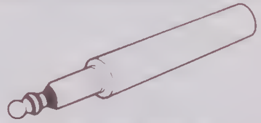
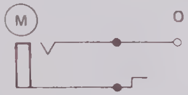
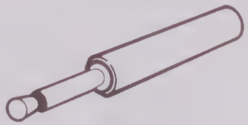
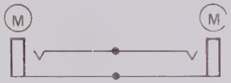
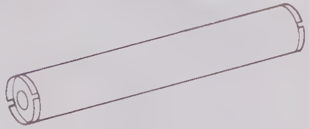
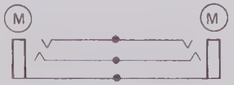
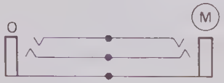
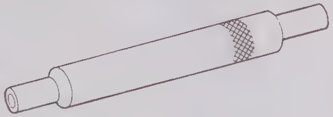
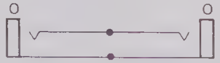
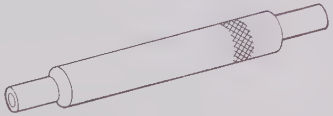
Type	Description	Coaxial Type Plugs
738A Plug	50-ohm attenuator plug, SMA series, which provides 3.0 ±0.5 dB attenuation at 13.25 GHz and 2.0 watts.	
738B Plug	50-ohm attenuator plug, SMA series which provides 10.0 ± 0.5 dB attenuation at 7 GHz and 2.0 watts (SMA).	
738C Plug	50-ohm attenuator plug, SMA series, which provides 20.0 ±0.5 dB attenuation at 13.25 GHz and 2.0 watts.	
794A Plug	3-way 75-ohm baseband signal splitter with BNC receptacle on each leg. (UG-290/U)	 
51994-XX Plug ☐	Looping and attenuator plug for connecting two telephone coaxial jacks through an Internal dB attenuator.	 

XX	dB
02	2
03	3
04	4
05	5
06	6
12	12

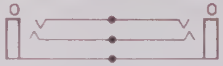
OPEN, LOOP, AND ATTENUATOR PLUGS (Cont'd)

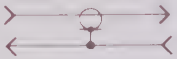
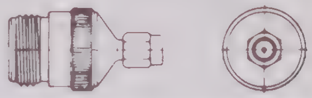
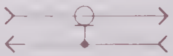
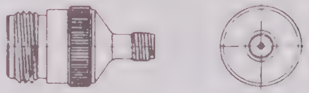
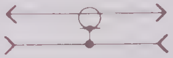
Type	Description	Special Purpose Plugs
52040 Plug	Loop-back test plug for LN/46B/47A Repeaters. Contains an 18-pin connector with straps.	 

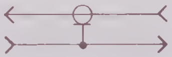
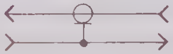
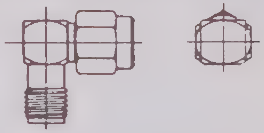
ADAPTERS

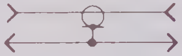
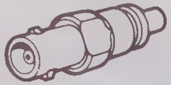
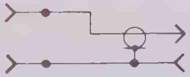
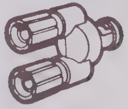
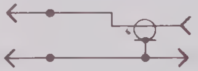
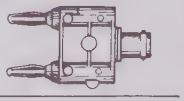
Type	Description	Telephone Type Adapters
6000H-01 Adapter	Telephone jack adapter for TRS standard to miniature connections.	 
6000H-02 Adapter	Telephone jack adapter for TS standard to miniature connections.	 
6000H-03 Adapter	Telephone plug adapter with TS miniature jack at both ends.	 
6000H-04 Adapter	Telephone plug adapter with TRS miniature jack at both ends.	
6000H-05 Adapter	Telephone plug adapter with TRS standard to TRS miniature jack.	 
6000H-06 Adapter	Telephone plug adapter with TS standard jack at both ends.	 

ADAPTERS (Cont'd)

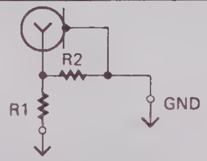
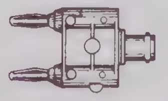
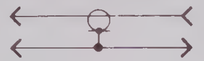
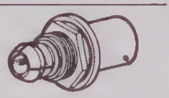
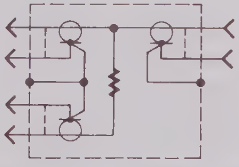
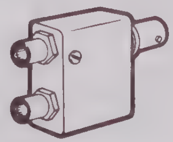
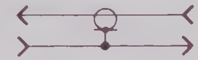
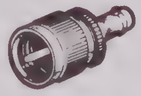
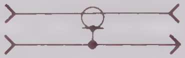
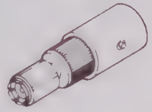
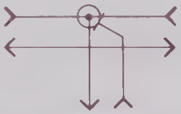
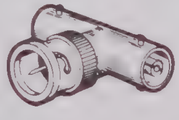
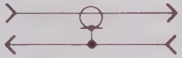
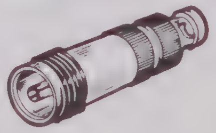
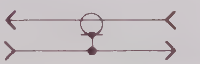
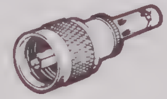
Type	Description	Telephone Type Adapters
6000H-07 Adapter	Same as -06 except TRS at both ends.	

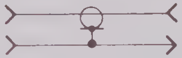
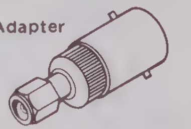
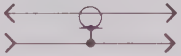
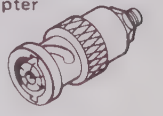
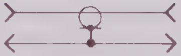
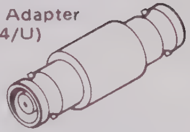
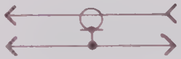
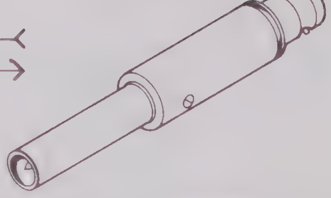
Type	Description	N Type Adapters
791A Adapter	N Female to SMA male coaxial adapter.	 
791B Adapter	N Female to SMA female coaxial adapter.	 
792A Adapter	N male to SMA male coaxial adapter.	

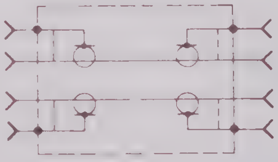
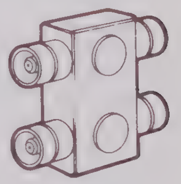
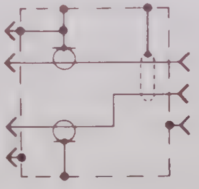
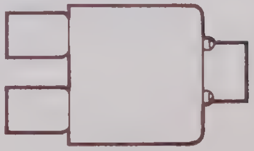
Type	Description	SMA Type Adapters
798A Adapter	Male SMA to female SMA	
799A Adapter	Right angle male to female SMA	 

Type	Description	BNC Type Adapters
701A Adapter	Female BNC to subminiature female coaxial adapter.	 
708A Adapter	Male BNC to banana binding posts type of adapter.	 
708B Adapter	Female BNC to male banana plug, type of adapter.	 

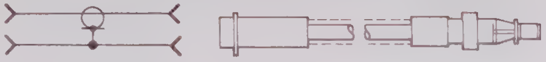
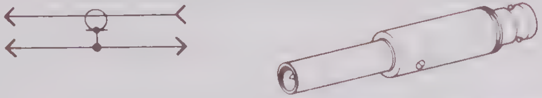
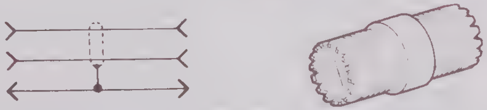
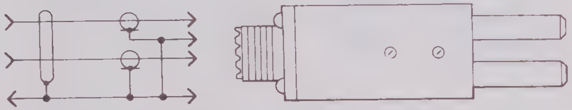
ADAPTERS (Cont'd)

Type	Description	BNC Type Adapters	
708C	Female BNC to male banana plug (GND) type of matching pad adapter (600/75Ω)		
711A Adapter	Female BNC to subminiature male SMP coaxial adapter.		
717A Adapter	Female BNC to subminiature male coaxial adapter with 75-ohm termination.		
745A Adapter	BNC female to uhf male coaxial connector. (UG-273/U)		
746A Adapter	Female microminiature plug to female BNC connector. Used to interconnect with male microminiature plug and male BNC connectors.		
750A Adapter	Coaxial tee adapter with two BNC female and one BNC male connectors. (UG-274/U)		
751A Adapter	Male BNC to female N coaxial connector. Interconnects shf signal generator to microwave receiver. (UG-349/U)		
751B Adapter	Female BNC to male N coaxial connector. Interconnects shf signal generator to microwave receiver. (UG-201/U)		

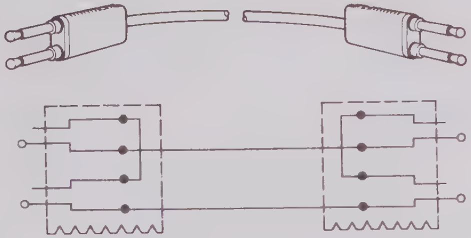
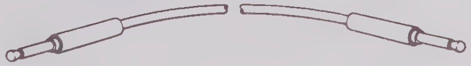
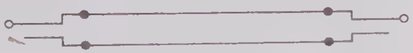
Type	Description	Adapter Kit	
44880 Adapter Kit	Kit contains four coaxial adapters which can be used with standard test cords for 75-Class testing.		Coaxial Adapter 
			Coaxial Adapter (UG-88/U) 
			Coaxial Adapter (UG-914/U) 
		☐ 	Coaxial Adapter 

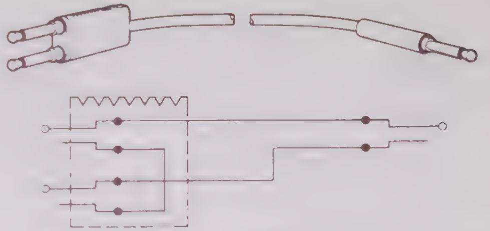
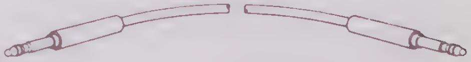
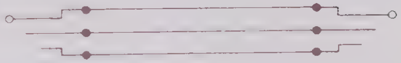
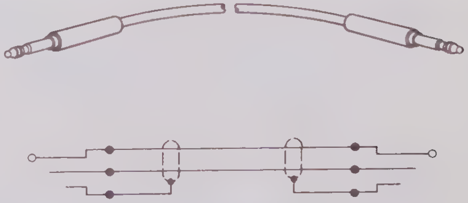
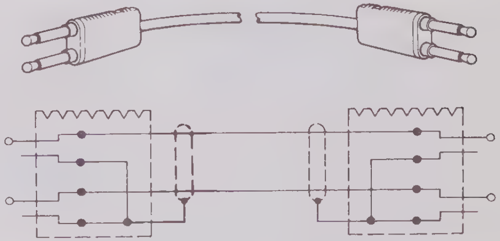
Type	Description	Coaxial Type Adapters	
709A Adapter	Twin subminiature female coaxial at both ends. Used to interconnect two test transformers having subminiature coaxial male connectors.		
720A Adapter	Female uhf-type, twin contact connector to twin subminiature male coaxial connectors. Used with 719A test cord. (UG-103/U)		

ADAPTERS (Cont'd)

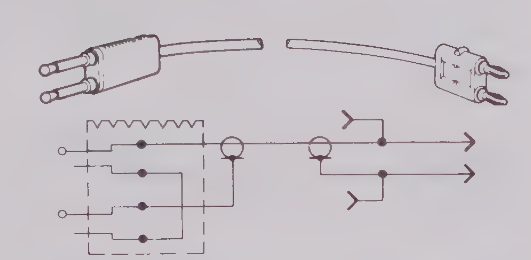
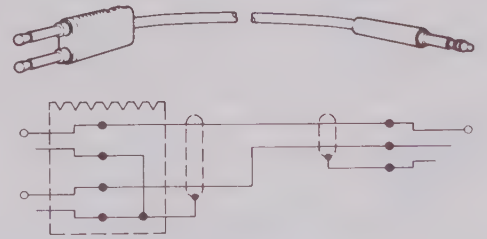
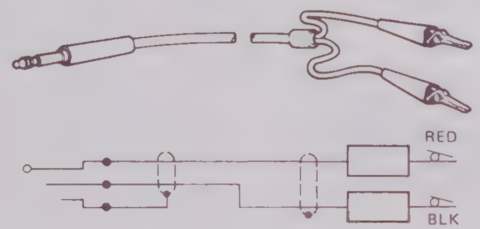
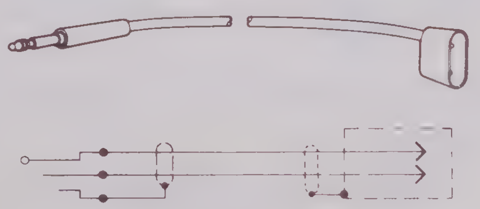
Type	Description	Coaxial Type Adapters
746B Adapter	Standard female coaxial connector (75 ohm) to sub-miniature female coaxial connector. Used to connect test equipment to coaxial pins in radio shelf.	
789A Adapter	Male standard coaxial connector to female BNC.	
6000F Adapter	Female uhf-type twin contact connector at both ends. (UG-105/U)	
6049A Adapter	Female uhf-type twin contact connector to dual miniature coaxial plug.	

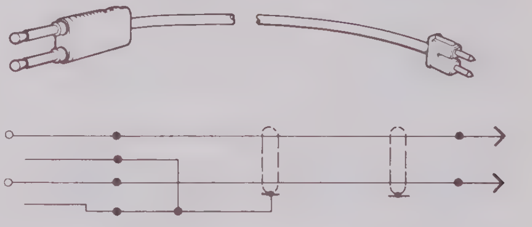
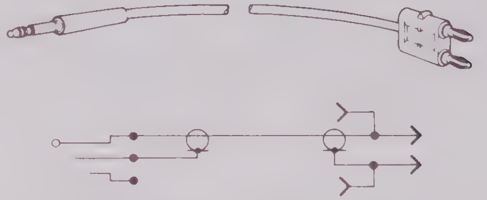
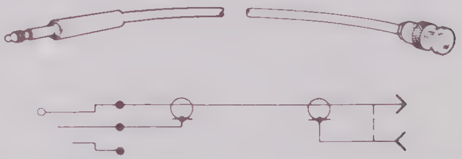
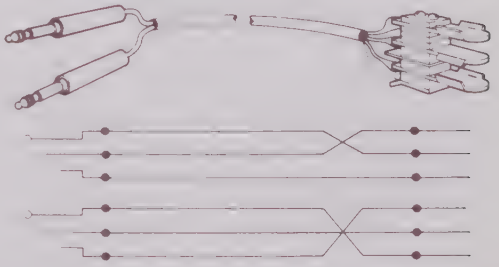
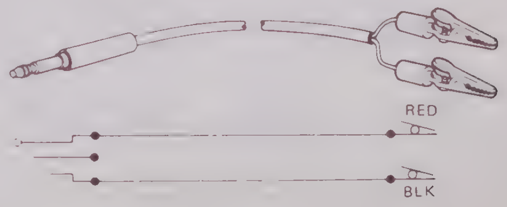
TEST CORDS AND SERVICE EXTENSION CABLES

Type	Description	Test Cords with Telephone Type Plugs
613A Cord ○	Double TS plug at each end wired tip-to tip. Cord used for patching test equipment with double jacks. Cord is 3 feet long.	
614A Cord ○	Same as 613A cord except length is 6 feet.	
621A Cord ○	Single TS plug at each end wired tip-to-tip. Cord used for patching test equipment with single jacks. Cord is 1 foot long.	
625A Cord ○	Same as 621A cord except cord length is 6 feet.	
631A ○	Same as 621A cord except cord length is 3 feet.	

Type	Description	Test Cords With Telephone Type Plugs
627A Cord ○	Single TS plug to double TS plug, wired tip-to-tip with cord. Used to patch or test circuits with single TS jacks on one end and double TS jacks at the other end. Length is 6 feet.	
632A Cord ○	Single TRS plug at each end. Cord used for patching test equipment with TRS jacks. Cord is 6 feet long.	
632B Cord ○	Same as 632A cord except cord length is 9 feet.	
632C Cord ○	Same as 632A cord except cord length is 15 feet.	
633A Cord ○	Single TRS plug at each end with a shielded sleeve. Slate cord used for patching shielded circuits with single TRS jack access. Cord is 6 feet long.	
633B Cord ○	Same as 633A cord except length is 15 feet.	
641A Cord ○	Double TS plug at both ends, wired tip-to-tip and shield-to-sleeves with cord. Used to patch or test hf carrier frequency circuits. Length is 6 feet.	

TEST CORDS AND SERVICE EXTENSION CABLES (Cont'd)

Type	Description	Test Cords With Telephone Type Plugs
646A Cord ○	Double TS plug connected to a molded twin banana plug. Cord is 6 feet long.	
646B Cord ○	Same as 646A cord except length is 10 feet	
662A Cord ○	Single TRS plug to double TS plug, shielded. Cord used to patch double jacks to single three conductor jacks. Length is 6 feet.	
663A Cord ○	Single TRS plug to crocodile clips, shielded cord. Used to patch three-conductor jack to test equipment not having jacks. Length is 6 feet.	
664A Cord ○	Single TRS plug to twin banana plugs; shielded. Cord patches test equipment to jackfields. Length is 6 feet.	

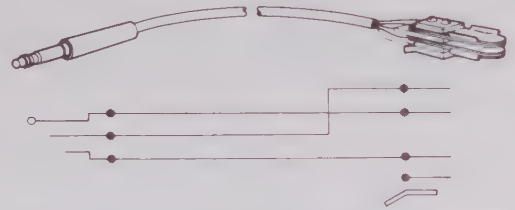
Type	Description	Test Cords With Telephone Type Plugs
684A Cord ○	Double TS with tips connected by shielded pair to twin pin plug; shield connected to sleeve of TS plug. Length is 9 feet.	
699A Cord ○	Single TRS plug to molded twin banana plug; coaxial RG-62/U. Patches test equipment to TRS jack. Length is 6 feet.	
712A Cord ○	Single TRS plug to UG-260/U (BNC) coaxial connector through RG-62/U coaxial. Used to patch test equipment to unbalanced baseband circuits. Length is 6 feet.	
722A Cord ○	TRS plugs (2) to 6-point test plug through 6 conductor cord. Length is 15 feet.	
723A Cord ○	Single TRS plug to alligator clips. Made of low resistance wire for use as a power cord. Length is 12 feet. Cord is two conductor.	

TEST CORDS AND SERVICE EXTENSION CABLES (Cont'd)

Type | **Description** | **Test Cords With Telephone Type Plugs**

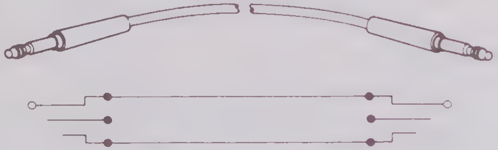
724A
Cord
○

Single TRS plug to four point test plug. Three conductor cord; length is 12 feet. Used to connect test equipment and unit being tested.



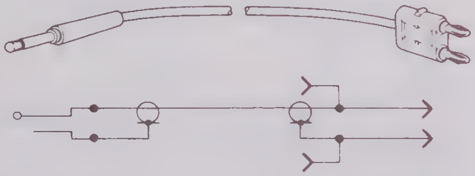
725A
Cord
○

Single TRS plug at each end, with TS connections. Made of low resistance wire for use as a power cord. Two conductor cord, 12 feet long.



727A
Cord
○

Single TS plug to molded twin banana plug, with coaxial RG-62/U. Used to patch test equipment to single TS jack. Length is 6 feet.

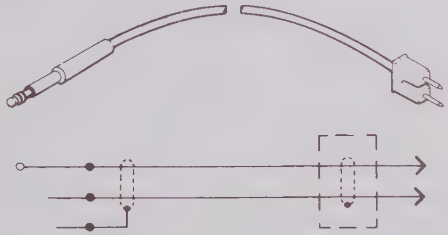


729A
Cord
○

Single TRS plug to twin pin plug. Two conductor cord with TR connections. Used for patching and test purposes. Length is 8-1/2 feet.

729B
Cord
Ⓜ

Same as 729A except miniature TRS plug.

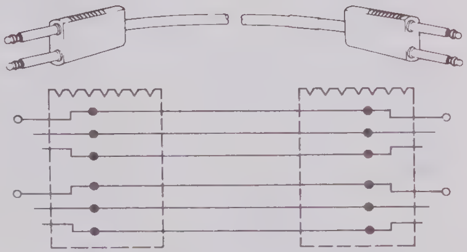


741A
Cord
○

Double TRS plug at each end; 6-conductor cord. Used to patch double TRS jacks. Length is 3 feet.

741B
Cord
○

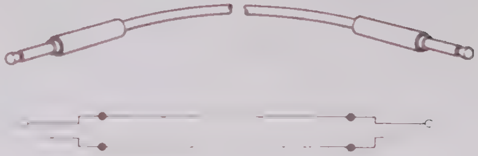
Same as 641A, except length is 6 feet.



Type | **Description** | **Test Cords With Telephone Type Plugs**

6025B
Cord
Ⓜ
○

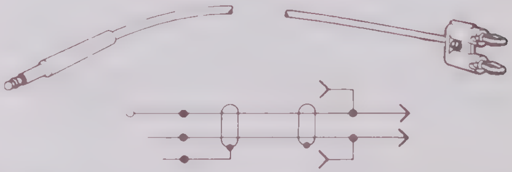
Miniature TS plug to standard TS plug; used to connect distortion measuring sets to telegraph systems. Length is 6 feet.



6100B-XX
Cord
(formerly 6000B)
Ⓜ
○

TRS miniature plug to twin banana plug. Two conductor shielded cord.

XX	LENGTH
01	5 Ft.
02	10 Ft.



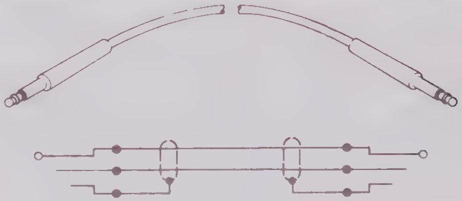
6100C-XX
Cord
(formerly 6000C)
Ⓜ

TRS miniature plug at both ends. Two conductor, shielded cord. Used to patch or test shielded circuits with single TRS jack access.

6100D-XX
Cord
(formerly 6000D)
Ⓜ
○

TRS miniature plug to TRS standard plug. Two conductor shielded cord. Used to connect standard TRS jacks on test sets to miniature TRS jacks on tested units.

XX	LENGTH
01	5 Ft
02	10 Ft

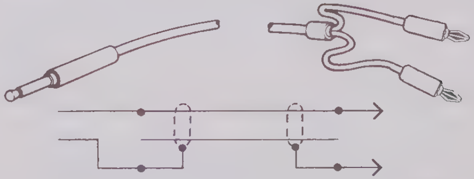


6100C-XX

XX	LENGTH
01	5 Ft
02	10 Ft
03	3 Ft
04	2.5 Ft

6100E
Cord
(formerly 6000E)
Ⓜ

TS miniature plug to single banana plugs. Single conductor shielded cord in 5-foot length

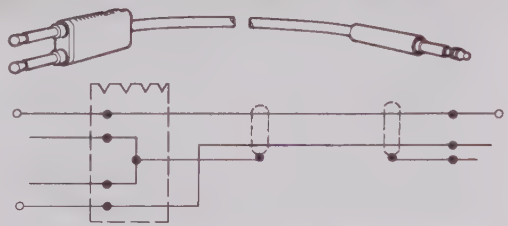


TEST CORDS AND SERVICE EXTENSION CABLES (Cont'd)

Type **Description** **Test Cords With Telephone Type Plugs**

6100F
Cord
○
Ⓜ

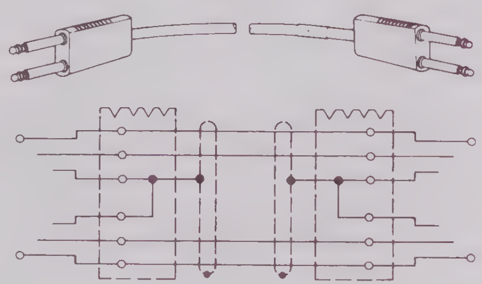
Double standard TS to single TRS miniature; two conductor shielded cord in 6-foot length.



6100G-XX
Cord
(formerly
6000G)
Ⓜ

Double miniature TRS at both ends. Five conductor shielded cord.

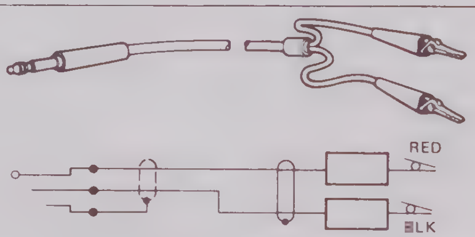
XX	LENGTH
01	2 Ft
02	3 Ft
03	6 Ft
04	10 Ft



6100J
Cord
Ⓜ

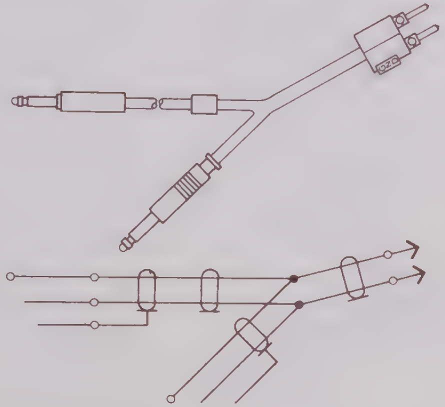
Miniature TRS plug to crocodile clips, shielded.

Used to patch three—conductor jack to test equipment or to test points not equipped with jacks. Cord is 6 feet long.



6100K
Cord
○
Ⓜ

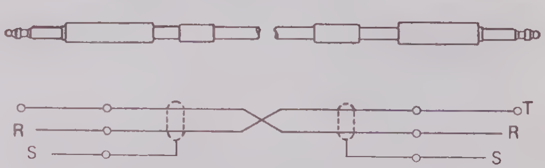
Standard TRS plug to miniature TRS plug and twin pin plug through two conductor, braided shield cord. Cord is 6 feet long.



Type **Description** **Test Cords With Telephone Type Plugs**

6100 L
Cord
○
Ⓜ

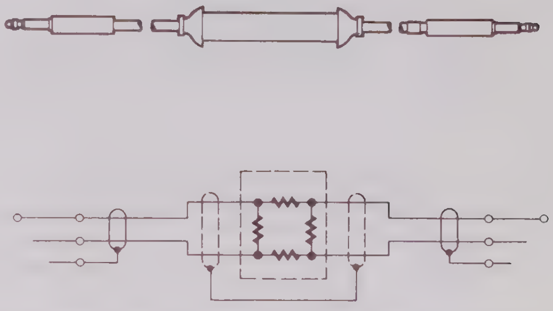
Standard TRS plug to miniature TRS plug. Tip and ring are cross-connected Twin Conductor shielded cord. Cord is 10 feet long.



6126A-XX
Cord
(formerly
6026A)
Ⓜ

TRS miniature plug at both ends. Two conductor, shielded cord with 23 dB attenuator built into center of cord.

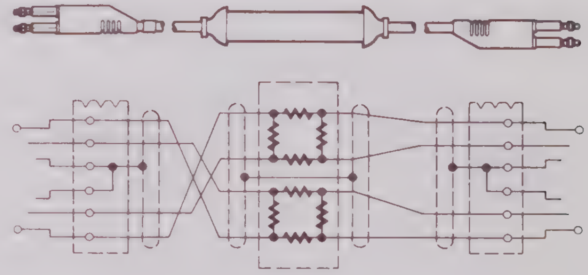
XX	LENGTH
01	6 Ft
02	10 Ft
03	15 Ft



6127A-XX
Cord
(formerly
6027A)
Ⓜ

Double miniature TRS plug at both ends. Four conductor, shielded cord with 23 dB attenuator built into center of cord.

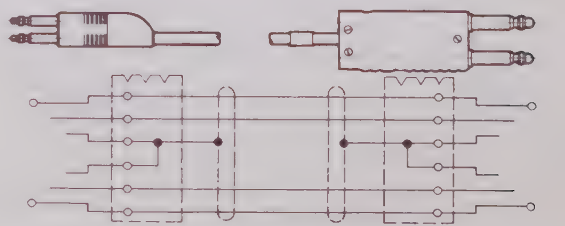
XX	LENGTH
01	6 Ft
02	10 Ft
03	15 Ft



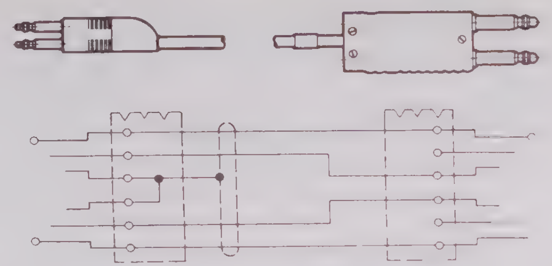
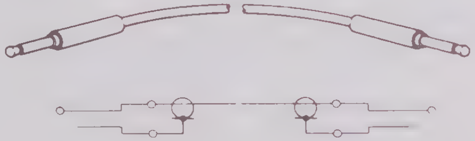
6128A-XX
Cord
(formerly
6028A)
Ⓜ
○

Double miniature TRS plug to double standard TRS plug through four conductor, braided shield cord.

XX	LENGTH
01	6 Ft
02	10 Ft



TEST CORDS AND SERVICE EXTENSION CABLES (Cont'd)

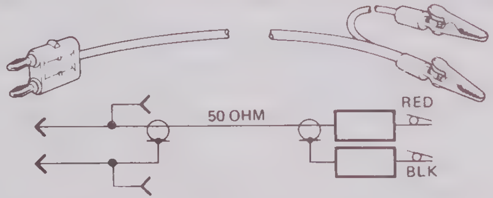
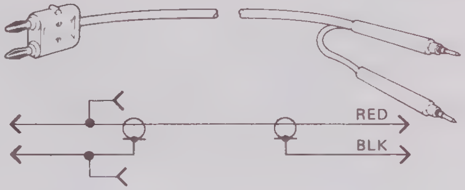
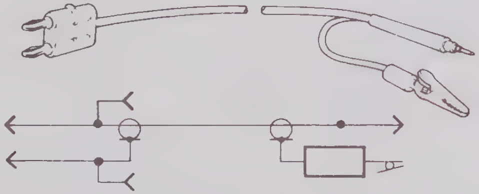
Type	Description	Test Cords with Telephone Type Plugs
6128B-XX Cord (formerly 6028B) Ⓜ ●	Double miniature TRS plug to double small (.210) TRS plug through four conductor, braided shield cord.	
6129A Cord Ⓜ	Miniature TS plug at both ends. One conductor, braided shield cord.	

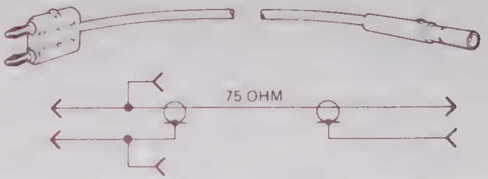
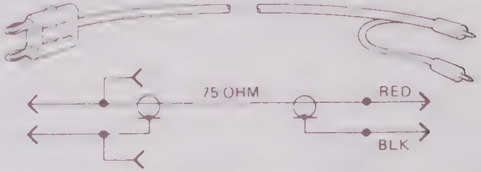
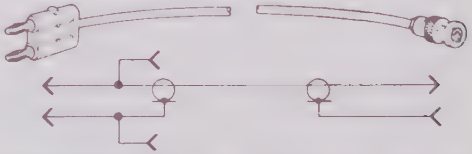
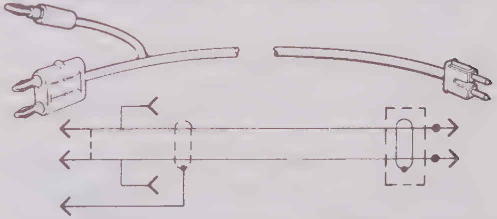
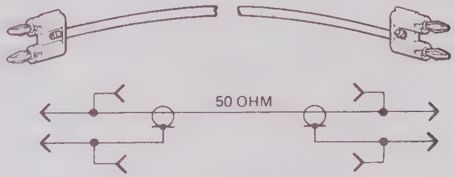
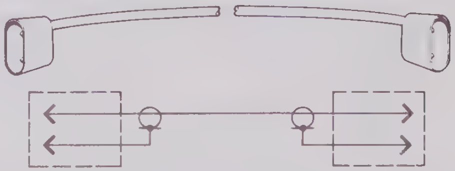
6128B-XX:

XX	LENGTH
01	6 Ft
02	10 Ft

6129A:

XX	LENGTH
01	6 Ft
02	10 Ft

Type	Description	Test Cords With Twin Banana Plugs
647A Cord	Molded twin banana plug to alligator clips, through coaxial RG-58/U. Length is 6 feet. Used to patch VTVM and other test equipment to hf points not equipped with jacks.	
651A Cord	Molded twin banana plug to pin prods, through coaxial RG-62/U. Length is 6 feet. Used to patch VTVM or other test equipment to pin jack test points.	
651C Cord	Molded twin banana plug to test prod and clip. Length is 6 feet. Used to patch VTVM or other test equipment not equipped with jacks.	

Type	Description	Test Cords With Twin Banana Plugs
674A Cord ☐	Molded twin banana plug to male standard coaxial plug through RG-59/U. Length is 6 feet. Used to patch equipment to hf test equipment.	
674B Cord	Molded twin banana plug to pin prods through coaxial RG-59/U. Patches test equipment to pin jack test points. Length is 6 feet.	
674C Cord	Molded twin banana plug to UG-260/U coaxial connector, through RG-59A/U. Length is 6 feet. Used to patch test equipment to hf equipment.	
684B Cord	Twin banana plug to twin pin jack plug; shield to single banana plug. Length is 8-1/2 feet. Connects test equipment to pin jacks.	
684D Cord	Twin banana plugs at each end; RG-58/U coaxial cable 3 feet long. Used to interconnect test equipment	
695A Cord	Twin banana plugs at each end, wired tip-to-tip. Coaxial RG-62/U, 1-1/2 Feet long. Used to patch test equipment to test equipment.	

647A:

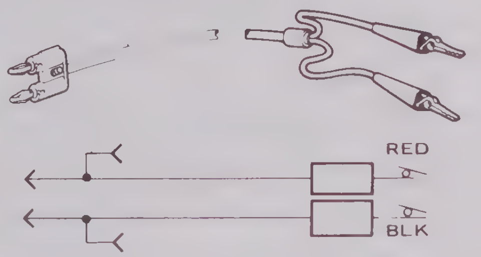
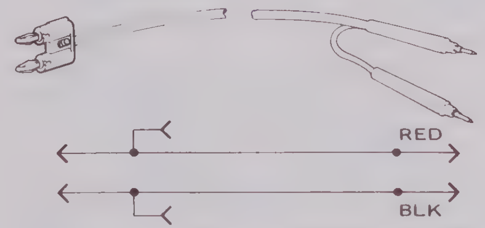
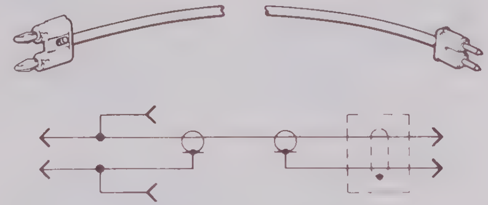
651A:

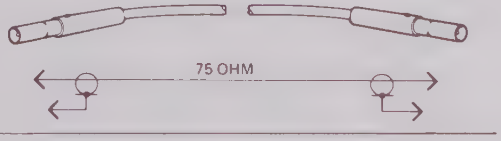
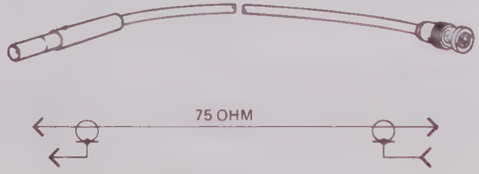
674A:

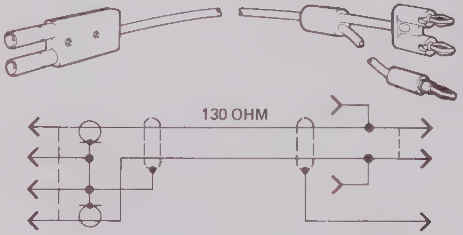
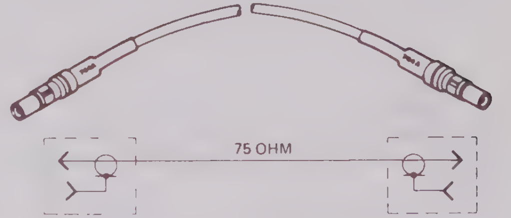
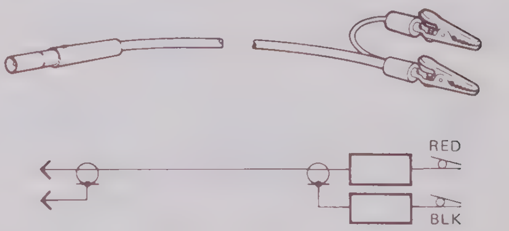
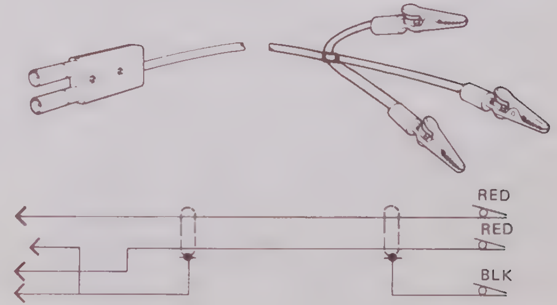
674B:

684D:

TEST CORDS AND SERVICE EXTENSION CABLES (Cont'd)

Type	Description	Test Cords With Twin Banana Plugs
6012A Cord	Double banana plug with ridged side connected to red lead of twin prod test wire, terminating with insulated alligator clips. Length is 4 feet.	
6014A Cord	Double banana plug with ridged side connected to red lead of twin test prod wire, terminating in pin prods. Length is 4 feet.	
6046J Cord	Twin banana plug through 75-ohm coaxial test cord to twin pin plugs. Length is 6 feet.	

Type	Description	Test Cords With Coaxial Type Plugs
673A Cord ☐	Male standard coax plugs at both ends of RG-59/U cable. Length is 2 feet. Used to patch or test hf equipment.	
693A Cord ☐	Male standard coax plug to UG-260/U (BNC) coax connector through RG-59/U cable. Length is 6 feet. Used to patch test equipment to hf equipment.	
6046A Cord M	Miniature coax plug to male BNC connector. Length is 6 feet.	

Type	Description	Test Cords With Coaxial Type Plugs
713A Cord ☐	Twin coaxial plug to twin banana plug, with shield ground to single banana plug. Length is 6 feet.	
744A Cord	Male miniature coaxial insert plugs at each end of RG-187/U. Length is 4 inches.	
753A Cord ☐	Male standard coax plug to two alligator clips through 6 feet of RG-59/U cable. Used to patch test equipment to hf equipment.	
754A Cord ☐	Double standard male coax plug to 3 alligator clips through 6 feet of two conductor, 124-ohm shielded cable. Used to patch test equipment to hf equipment.	

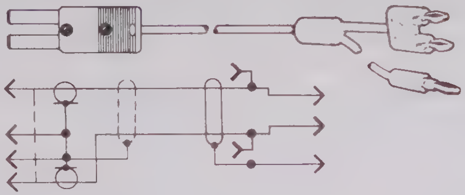
TEST CORDS AND SERVICE EXTENSION CABLES (Cont'd)

Type | **Description** | **Test Cords With Coaxial Type Plugs**

6046B Cord

M

Double male miniature coax plug to twin banana plug and grounded single banana plug through shielded pair test cord. Length is 6 feet.

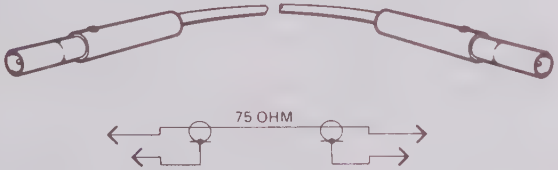


6046C Cord

M

Male miniature coaxial plug on both ends of coaxial test cord, RG-59/U.

XX	LENGTH
01	2 Ft
02	6 Ft
03	10 Ft
04	0.5 Ft
05	1 Ft
06	1.5 Ft
07	2.5 Ft

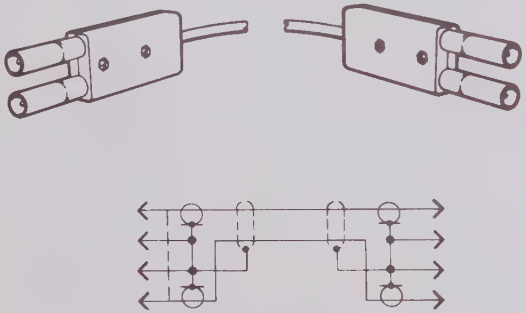


6046D Cord

M

Double male miniature coaxial plug on each end of balanced, shielded pair test cord.

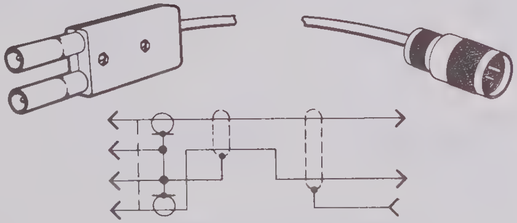
XX	LENGTH
01	2 Ft
02	6 Ft
03	10 Ft



6046H Cord

M

Double male miniature coax plug to male uhf-type twin (UG-102/U) connector through shielded pair test cord. Length is 6 feet.



Type | **Description** | **Test Cords With Coaxial Type Plugs**

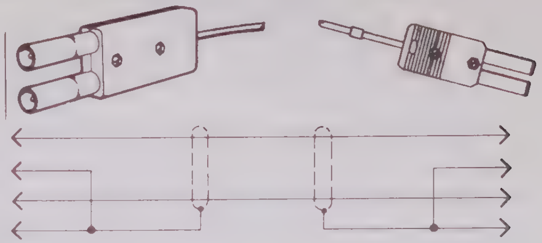
6046K Cord

☐

M

Double male standard coaxial plug to double male miniature coaxial plug through 124-ohm video cable.

XX	LENGTH
01	6 Ft
02	10 Ft



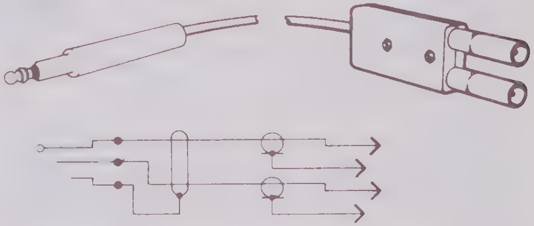
6046L-XX Cord

Ⓜ

☐

Single miniature TRS plug to standard double male coaxial plug through 124-ohm video cable.

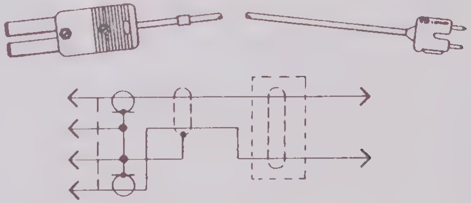
XX	LENGTH
01	6 Ft
02	10 Ft



6046M Cord

M

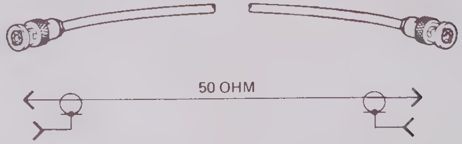
135-ohm balanced double male miniature coax plug to twin pin plug. Length is 6 feet.



Type | **Description** | **Test Cords With Coaxial Connectors**

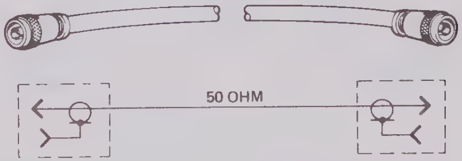
648A Cord

Male UG-88/U (BNC) coax connectors at both ends; coaxial RG-58/U. Length is 6 feet. Used to patch or test radio equipment.

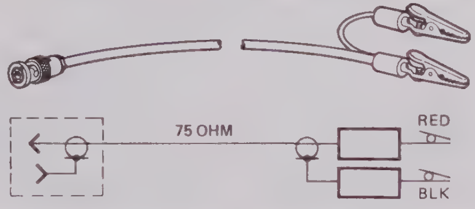
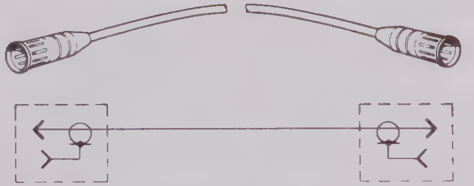
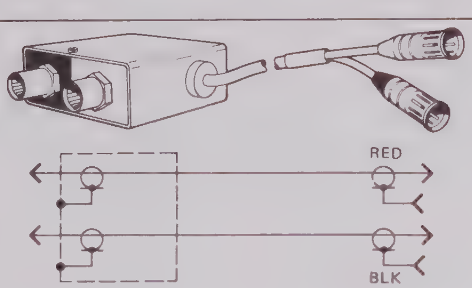
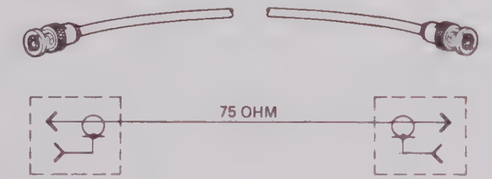
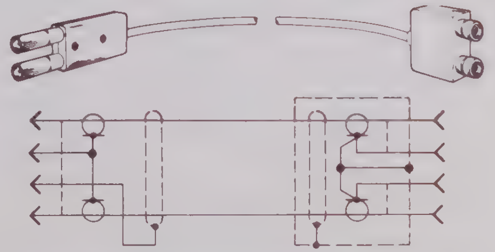


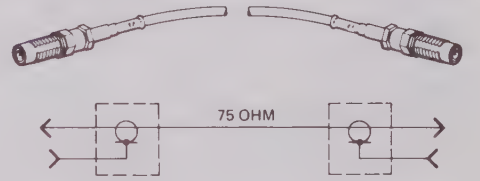
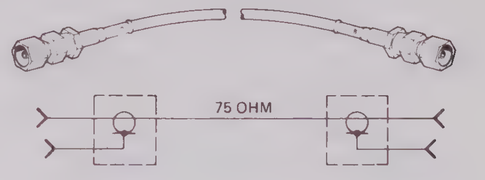
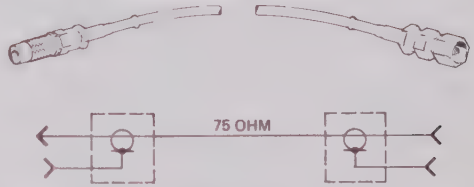
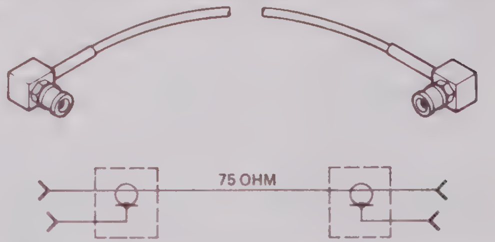
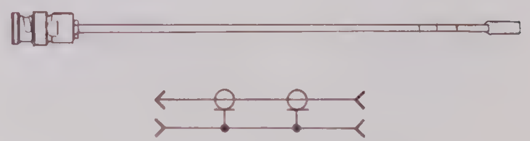
661A Cord

Male UG-21B/U (N) coax connectors at both ends; coaxial RG-8/U. Length is 6 feet. Used to patch or test radio equipment.

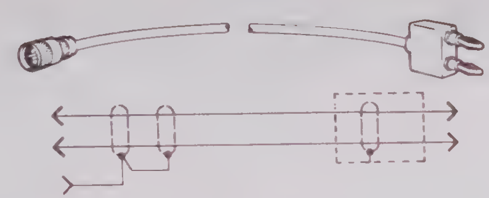
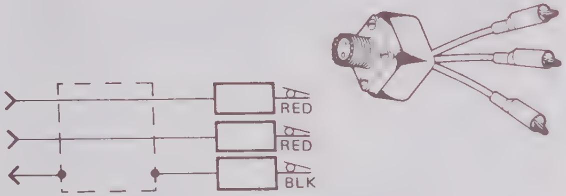
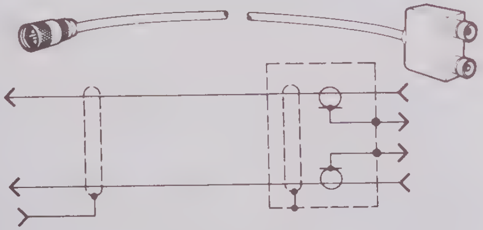
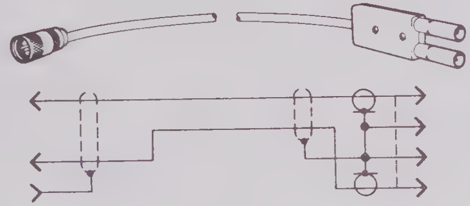


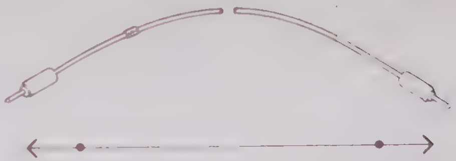
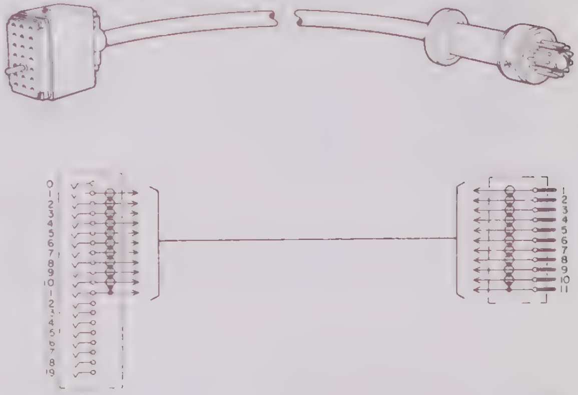
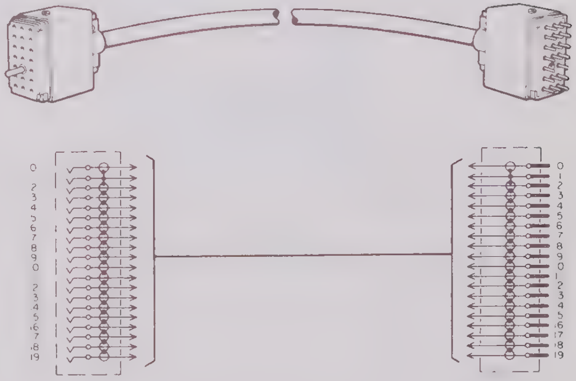
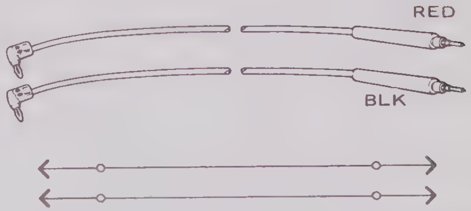
TEST CORDS AND SERVICE EXTENSION CABLES (Cont'd)

Type	Description	Test Cords With Coaxial Connectors
693B Cord	UG-260/U (BNC) coaxial connector to alligator clips through coaxial RG-59/U cable. Length is 6 feet. Used to patch test equipment to hf equipment.	
700A Cord	Subminiature coaxial connectors at both ends. Length is 1-1/2 feet. Used with service extension units.	
703A Cord	Subminiature coaxial connectors at both ends of balanced 130-ohm test cord. Length is 7 feet.	
721A Cord	UG-260/U male (BNC) connectors at both ends of RG-59/U coaxial cable. Length is 1-1/2 feet. Used to patch or test radio equipment. (75 ohm)	
721B Cord	Same as 721A, except length is 3 feet.	
721C Cord	Same as 721A, except length is 6 feet.	
728A Cord ☐	Twin coaxial plug to twin female subminiature connector. Length is 6 feet.	

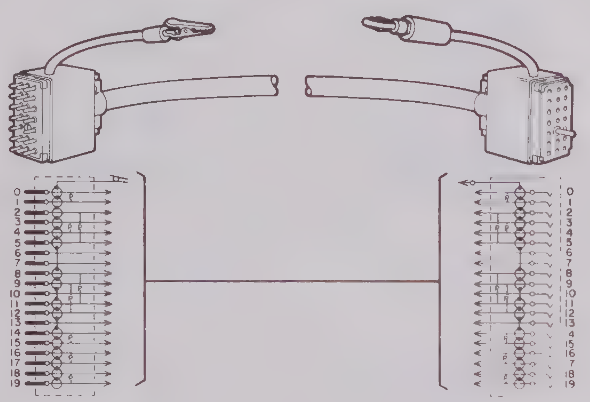
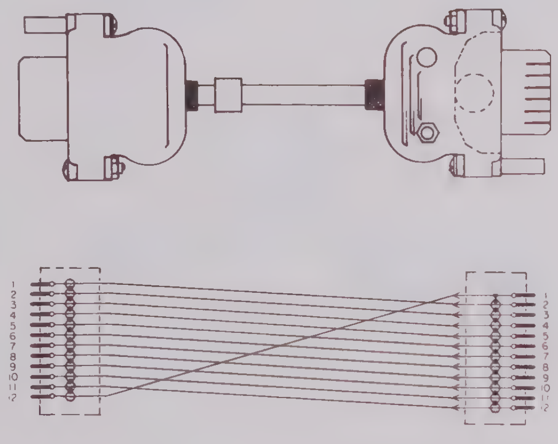
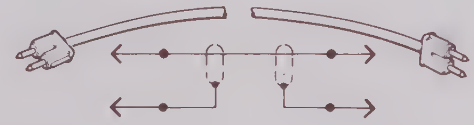
Type	Description	Test Cords With Coaxial Connectors
732A Cord	Subminiature male coaxial connectors at each end of RG-187/U. Used for patching or testing 75-ohm circuits with female subminiature coaxial connectors. Length is 3 feet.	
732B Cord	Subminiature female coax connector at each end of RG-187/U. Length is 3 feet. Used for patching or testing 75-ohm circuits with male subminiature coax connectors.	
790A Cord	Subminiature female coax connectors at both ends of RG-398 (50-ohm). Length is 1 foot.	
790B Cord	Same as 790A Cord, except length is 10 feet.	
732C Cord	Subminiature male coaxial connector to subminiature female coaxial connector through RG-187/U. Used for patching or testing circuits with mating male and female connectors. Length is 3 feet.	
743A Cord	Subminiature female snap-on connectors at each end of RG-187/U. Used for patching or testing circuits with male subminiature coax connectors. Length is 4 inches.	
▶ 774A	RG-187/U test cord with BNC connector on one end and modified female Berg MINI PV connector on the other. Length is 1.25 feet.	

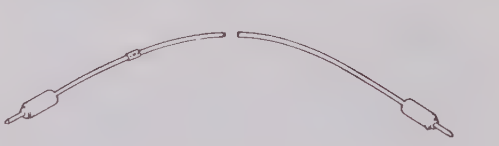
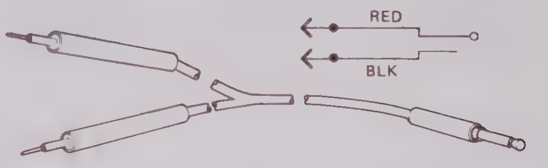
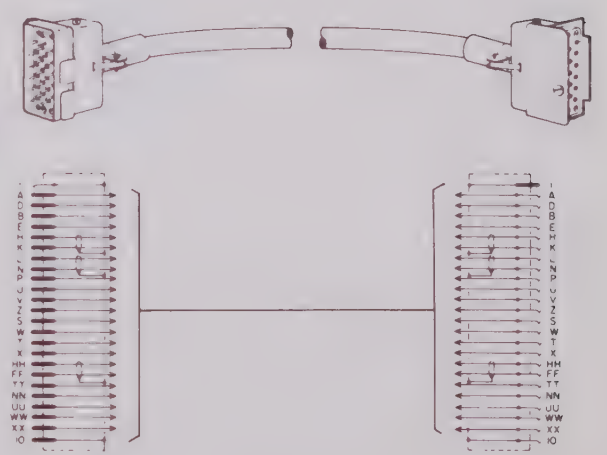
TEST CORDS AND SERVICE EXTENSION CABLES (Cont'd)

Type	Description	Test Cords With Twin Conductor UHF Type Connectors
714A Cord	Male uhf-type (UG-102/U), twin contact connector to twin banana plug through twin conductor shielded test cord. Used to patch test equipment to balanced baseband circuits. Length is 6 feet.	
714B Cord	Female uhf-type (UG-103/U) twin contact connector to (3) alligator clips. Used to patch test equipment to hf equipment.	
716A Cord	Male uhf-type (UG-102/U), twin contact connector to twin female subminiature connectors. Used to connect balanced baseband circuits to test transformers. Length is 1-1/2 feet.	
719A Cord ☐	Male uhf-type (Ug-102/U), twin contact connector to double hf coaxial plug. Used to patch test equipment to vf equipment. Length is 6 feet.	

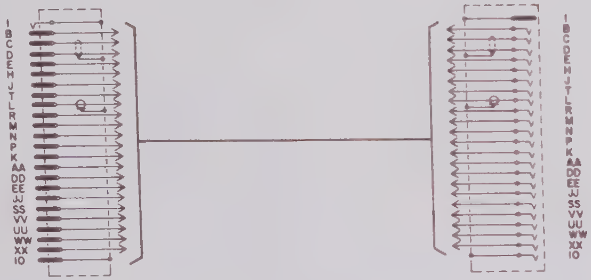
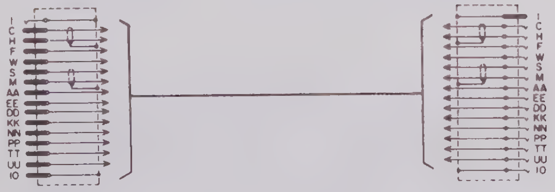
Type	Description	Special Purpose Test Cords And Service Extension Cables
636A Cord	Single pin red prod at both ends. Used to patch test equipment to pin jack test points. Length is 1 foot.	
649A Cord	Patch cord; 11-pin male to 20-pin female. Patches test set to vf and signaling circuits. Length is 9 feet. (For 45-class eqpt.)	
650A Cord	Patch cord; 20-pin male to 20-pin female. Patches test set to hf circuits and extends units from shelf positions for bench testing. Length is 9 feet. (For 45-class eqpt.)	
651B Cord	Banana plug prods to test prods. Used to patch test equipment not equipped with jacks to pin jack test points. Length is 3 feet.	

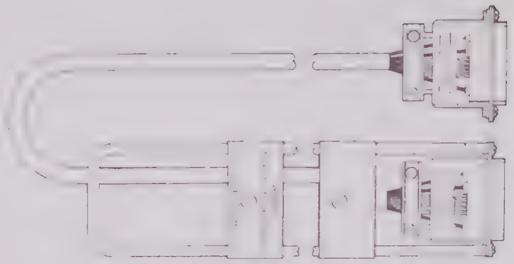
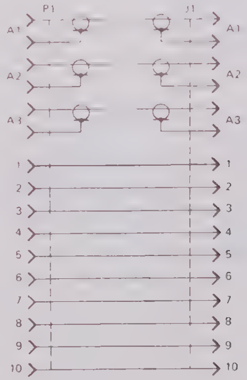
TEST CORDS AND SERVICE EXTENSION CABLES (Cont'd)

<table>
<tr><th>Type</th><th>Description</th><th>Special Purpose Test Cords And Service Extension Cables</th></tr>
<tr><td>683A Cord</td><td>20-pin male to 20-pin female.
Used to patch 681B repeater switching set.</td><td> </td></tr>
<tr><td>796A-XX</td><td>12-pin male to 12-pin male. Used to patch channel unit to 91442 or 91443 test set.<table><tr><th>XX</th><th>Length</th></tr><tr><td>01</td><td>6 Ft</td></tr><tr><td>02</td><td>12 Ft</td></tr></table></td><td> </td></tr>
<tr><td>684G</td><td>Two conductor shielded cable with twin pin jack plugs on both ends. 2 feet long.</td><td></td></tr>
</table>

Type	Description	Special Purpose Test Cords And Service Extension Cables
6015A Cord	Single pin black prod at both ends. Used to patch test equipment to pin jack test points. Length is 2 feet.	
6015B Cord	Same as 6015A except red prods.	
6025A Cord	Pin test probes to TS plug. Length is 6 feet. Used to connect distortion measuring set to telegraph systems.	
44892 Cord	Multi-pin female to male connectors through plastic covered cable. Length is 4 feet. (For 75-class eqpt.)	

TEST CORDS AND SERVICE EXTENSION CABLES (Cont'd)

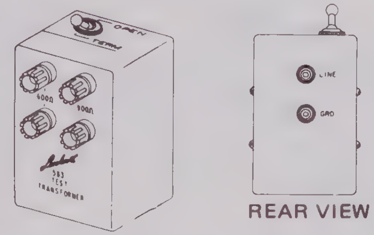
Type	Description	Special Purpose Test Cords And Service Extension Cables
44893 Cord	Same as 44892 Cord; different shielding provisions (for 75-class eqpt.).	 I B C D E H J T L R M N P K AA DD EE JJ SS VV UU WW XX 10
44894 Cord	Same as 44892 cord; different shielding provisions (for 75-class eqpt.).	 I C H F W S M AA EE DD KK NN PP TT UU 10

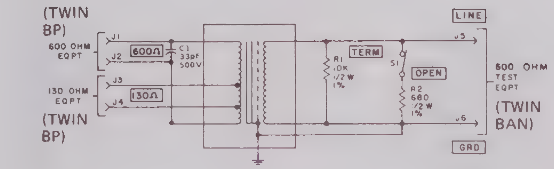
Type	Description	Special Purpose Test Cords And Service Extension Cables
48527 Cord	Male 10 pin, 3 coaxial connector to female 10 pin, 3 coaxial connector. A service extension cable, used to extend 78-series radio plug-in unit from its shelf.	  P1 J1 A1 A2 A3 1 2 3 4 5 6 7 8 9 10

TEST TRANSFORMERS

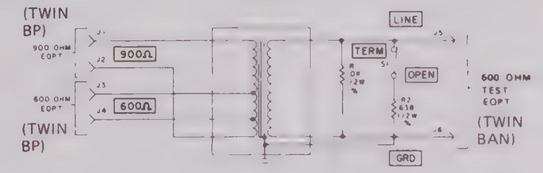
Type | Description | Test Transformers

583B Transformer with 600:130/600 ohm impedance ratio for connecting test equipment with unbalanced terminals to balanced 130-ohm or 600-ohm circuits. Frequency range; 5 kHz to 1000 kHz, 0.2 dB insertion loss at 120 kHz.

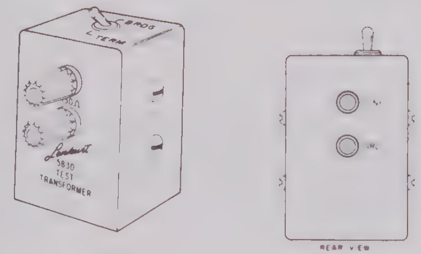

583 TEST TRANSFORMER
600Ω
130Ω
OPEN
TERM
LINE
GRD
REAR VIEW

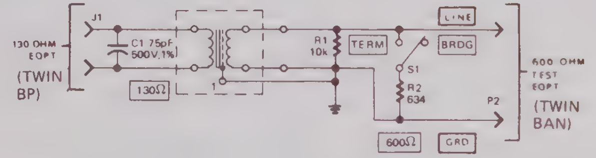

(TWIN BP)
600 OHM EQPT
130 OHM EQPT
(TWIN BP)
J1
J2
J3
J4
600Ω
130Ω
C1 33pF 500V
R1 10K 1/2W 1%
TERM
S1
OPEN
R2 680 1/2W 1%
LINE
GRD
J5
J6
600 OHM TEST EQPT
(TWIN BAN)

583C Transformer which converts 600-ohm or 900-ohm balanced impedance to 600-ohm unbalanced impedance. Frequency range: 100 Hz to 10 kHz, 1.0 dB insertion loss at 1 kHz.

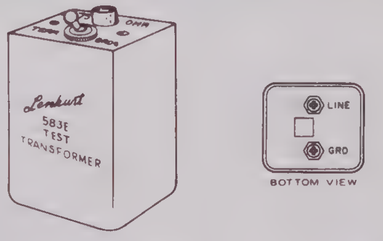

(TWIN BP)
900 OHM EQPT
600 OHM EQPT
(TWIN BP)
900Ω
600Ω
LINE
TERM
S1
OPEN
R2 638
GRD
600 OHM TEST EQPT
(TWIN BAN)

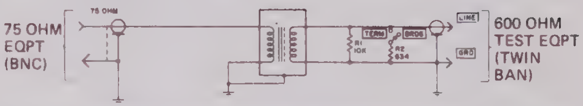
583D Transformer that provides impedance matching between 600-ohm unbalanced test equipment and 130-ohm balanced circuits. Frequency range: 12 kHz to 3.1 MHz, 0.2 dB insertion loss.


BRDG
TERM
583D TEST TRANSFORMER
REAR VIEW

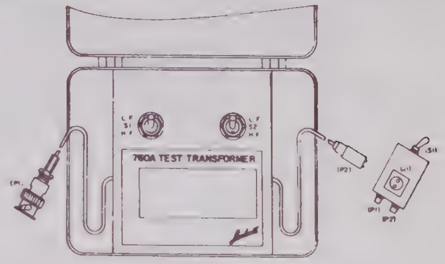

130 OHM EQPT
(TWIN BP)
J1
C1 75pF 500V,1%
130Ω
R1 10k
TERM
LINE
BRDG
S1
R2 634
P2
600Ω
GRD
600 OHM TEST EQPT
(TWIN BAN)

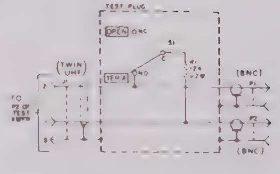
583E Transformer that provides impedance matching between 75-ohm and 600-ohm circuits. Frequency range: 12 kHz to 3.1 MHz, 0.5 dB maximum insertion loss.

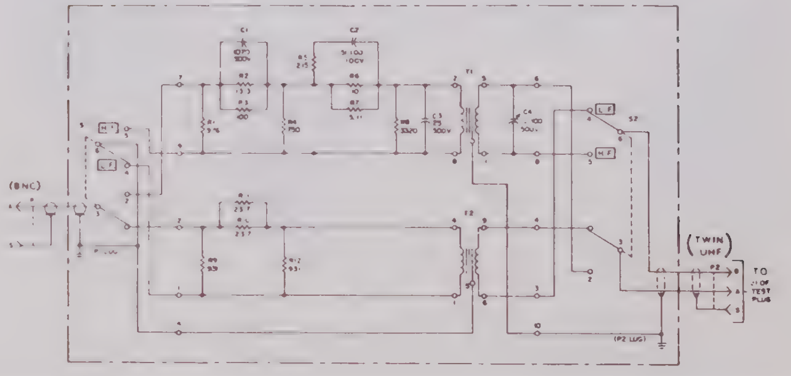

Lenkurt
583E TEST TRANSFORMER
LINE
GRD
BOTTOM VIEW


75 OHM EQPT (BNC)
75 OHM
R1 10K
TERM
BRDG
R2 634
LINE
GRD
600 OHM TEST EQPT (TWIN BAN)

760A Transformer & test plug that provide impedance matching circuitry between 75-ohm test equipment and 124-ohm circuits. Frequency ranges: (LF) 20 Hz to 20 kHz, (HF) 20 kHz to 10 MHz, 2 dB insertion loss.


760A TEST TRANSFORMER
LF S1 HF
LF S2 HF
(P1)
(P2)
(S1)


TEST PLUG
OPEN
TERM
S1
(TWIN UHF)
(BNC)
P1
P2
TO P2 OF TEST XFMR


(BNC)
C1
C2
C3
C4
T1
T2
S2
LF
HF
(TWIN UHF)
P2
TO J1 OF TEST PLUG
(P2 LUG)

032—201—150

GTE LENKURT

Company Headquarters
1105 County Road
San Carlos, California 94070
Phone: 415—595-3000

Microwave & Analog Products Division
1105 County Road
San Carlos, California 94070
Phone: 415—595-3000

10727 Gateway West
El Paso, Texas 79935
Phone: 915—593-3400

Digital Products Division
One Camino de Lenkurt
Albuquerque, New Mexico 87123
Phone: 505—296-0551

Special Service Products Division
876 Ventura Street
Aurora, Colorado 80011
Phone: 303—340-8400

Fiber Optics Communications Division
1230 Charleston Road
Mt. View, California 94043
Phone: 415—962-8630

District Sales Offices
1105 County Road
San Carlos, California 94070
Phone: 415—595-3000

301 Williams Drive
Suite 110
Fairfax, Virginia 22031
Phone: 703—698-1850

5780 Peachtree-Dunwoody Road, N.E.
Suite 145
Atlanta, Georgia 30342
Phone: 404—256-3000

120 West Eastman Street
Arlington Heights, Illinois 60004
Phone: 312—398-6700

542 Haggard Street, Suite 510
Plano, Texas 75074
Phone: 214—422-4305

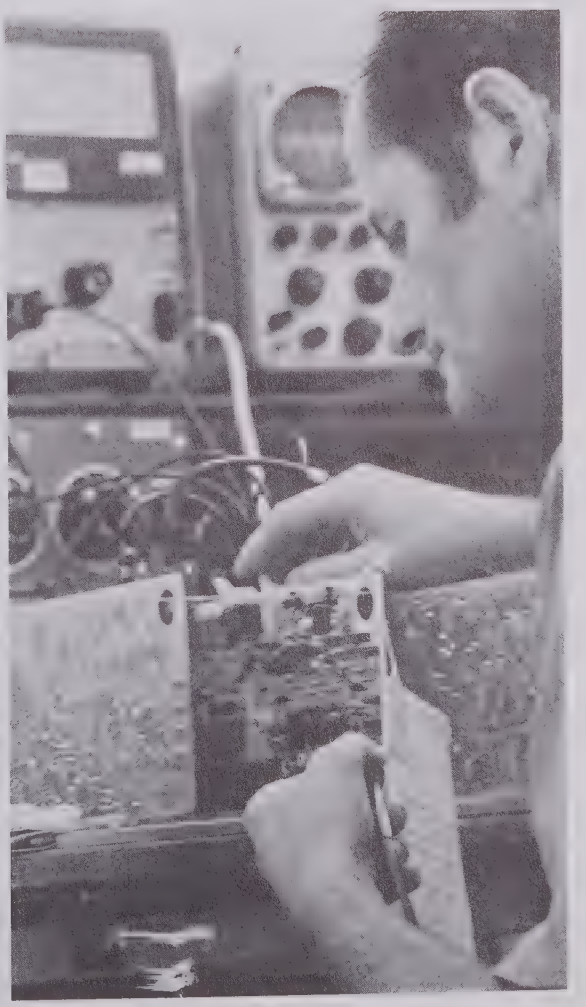
GTE International Sales Office
1105 County Road
San Carlos, California 94070
Phone: 415—595-3000
Cable: GENTELINT

GTE LENKURT

September 1979 Issue Two

Factory Repair Service

- Fast and efficient factory repair service is available for all repairable types of GTE Lenkurt equipment.
- Typical repair and return cycle is 14 to 21 calendar days, after receipt of equipment.
- Loaner units (CARE) available to protect critical service.
- Replacement of new equipment under warranty (NEWREP) when timing of service is critical.
- Repaired units receive required engineering changes, and are tested to factory specifications, ensuring top quality performance.
- GTE Lenkurt Factory Service Representatives may be contacted 24 hours a day, 7 days a week. Call 415–595-3000.



Advanced developments in electronic telecommunications systems involving thin- and thick-film substrates, integrated circuits and other solid-state and microminiaturized devices have made field repair of defective assemblies economically impractical. In fact, GTE Lenkurt no longer recommends field repair for new models of its telecommunications equipment, and encourages customers to stock spare plug-in units, and other critical assemblies. Realizing these circumstances require fast and efficient factory repair, the company established a Factory Repair Service with the responsibility of correcting your equipment problems fast and efficiently.

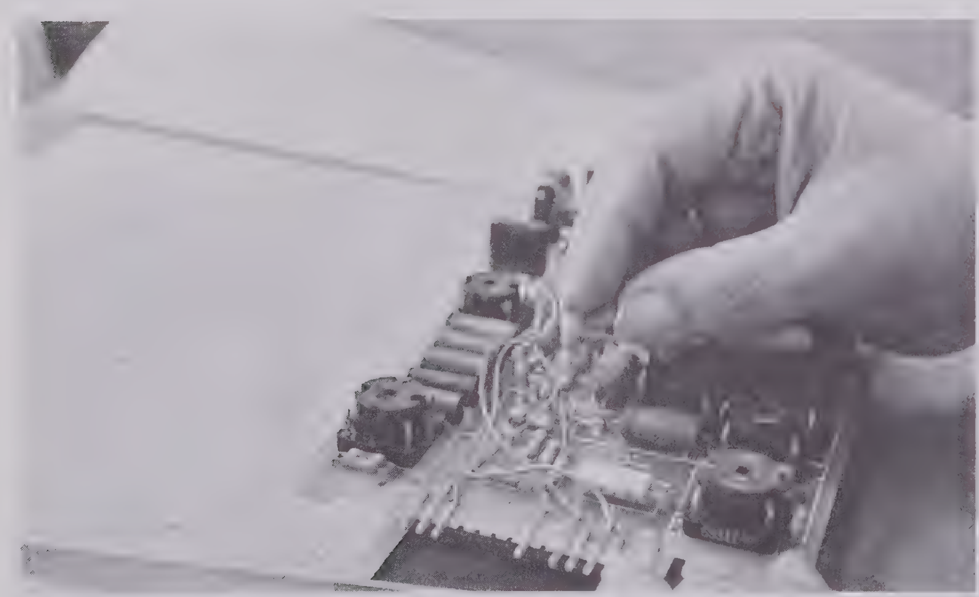
Items sent in are given prompt attention. In addition to repairs, defective units receive required engineering changes, and detailed tests to assure top performance.

Usually, no charges are made for repair of equipment under warranty. However, the replacement of a new unit after 7 months does entail a restocking charge. For items no longer under warranty, the repair charge is based upon the average cost of material and labor required to locate and repair defects, and to test the equipment against factory test specifications. All repairs carry a 90-day warranty or the balance of the original equipment warranty, whichever is longer.

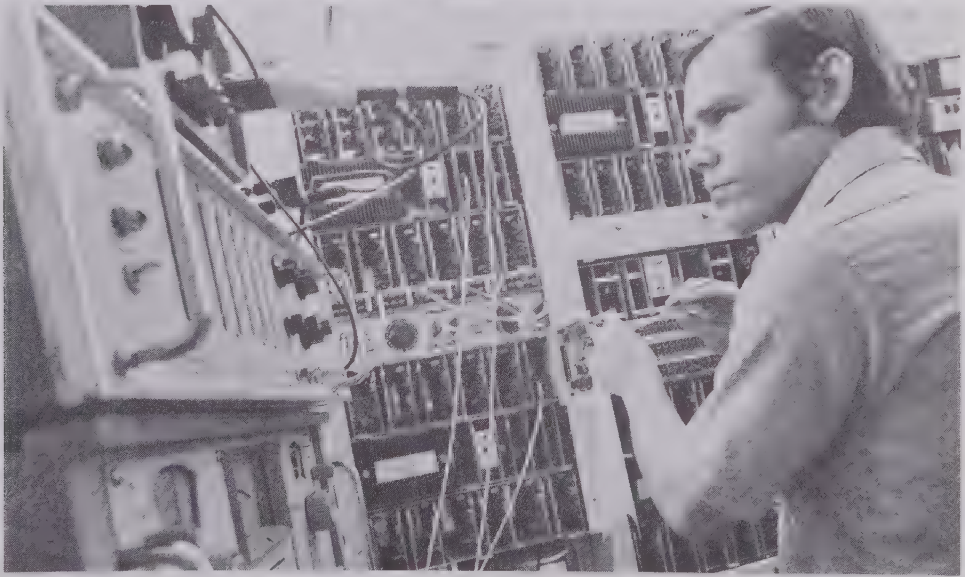
Normally, defective equipment is repaired and shipped within 14 to 21 calendar days after receipt. It should be noted, however, that units classified A&M and units requiring aging require a longer repair cycle. Also, the repair of items classified MD is dependent upon the availability of components and other materials.

Additionally, if your equipment is out of service and you do not have the necessary spare backup assemblies available, GTE Lenkurt is prepared, in most cases, to loan you a temporary replacement. GTE Lenkurt calls this equipment for loan, Customer Accommodation Restoration Equipment (CARE). CARE is intended as a temporary backup, and it is a requirement that the CARE unit be returned once you have received your repaired equipment.

NOTE: Factory repair and CARE service are designed to support operating systems. For emergencies resulting from defective units included in shipments of new equipment, refer to NEWREP service.



Every item sent in for repair service receives prompt attention. All required engineering changes are incorporated and it gets factory tests.



To assure like-new performance, the repaired unit is subjected to extensive factory testing.

Only a phone call away, GTE Lenkurt Factory Representatives are standing by to handle any repair problem you might have.

REPAIR AND RETURN SERVICE PROCEDURE

The easiest and most convenient method of obtaining repair and return service is to attach a trouble reporting tag (figure 1) to the defective unit and ship it (charges prepaid) to:

Factory Service Department
GTE Lenkurt Incorporated
1105 County Road
San Carlos, California 94070

The trouble reporting tag should be filled out with the trouble symptoms. We ask for the name and telephone number of the technician reporting the malfunction, since our serviceman may need to contact him. Also enclose a purchase order or your company's blanket repair service order number, and shipping and billing instructions. Pack the equipment carefully. Shipping should be by some traceable mode. Shipment by air will expedite your order.

Upon receipt of your equipment, GTE Lenkurt will mail an acknowledgement. If you have any questions about shipping dates, contact a GTE Lenkurt Factory Service Representative: Telephone 415–595-3000, Telex 34-8425, TWX 910-376-4396.

CARE

If your system is out of service or if critical service is threatened, telephone a GTE Lenkurt Factory Service Representative and request a CARE unit. Call any time — your message will be taken 24 hours a day, 7 days a week (415–595-3000). Our representative will immediately confirm the shipment of a CARE unit, and in such cases where a unit is not available, will arrange to expedite your repair order.

There is a CARE handling charge of 10% of the cost of the unit. Charges for the use of CARE units are billed at the time of shipment. To protect our inventory, the CARE unit must be returned within 60 days after return shipment of the repaired unit; otherwise you will be charged the full purchase price of the unit plus a 25% penalty.

NEW EQUIPMENT REPLACEMENT UNDER WARRANTY (NEWREP)

A stock of standard types of new equipment replacement (NEWREP) units is also maintained for emergencies resulting from possible defects found in shipments of new equipment. NEWREP service is available only when all of these conditions apply:

(a) The defective unit is less than 12 months old.
(b) The defective unit has not yet been in regular service, and, therefore, is in new condition.
(c) Your installation schedule does not allow sufficient time for repair under warranty.

There is no charge for the NEWREP item if the defective item is less than 7 months old. For defective units 7 to 12 months old, there is a restocking charge equal to 10% of the unit list price.

The defective unit must be returned within 60 days after the shipment of a NEWREP unit or full list price plus a restocking charge of 100% of the unit list price will be imposed.

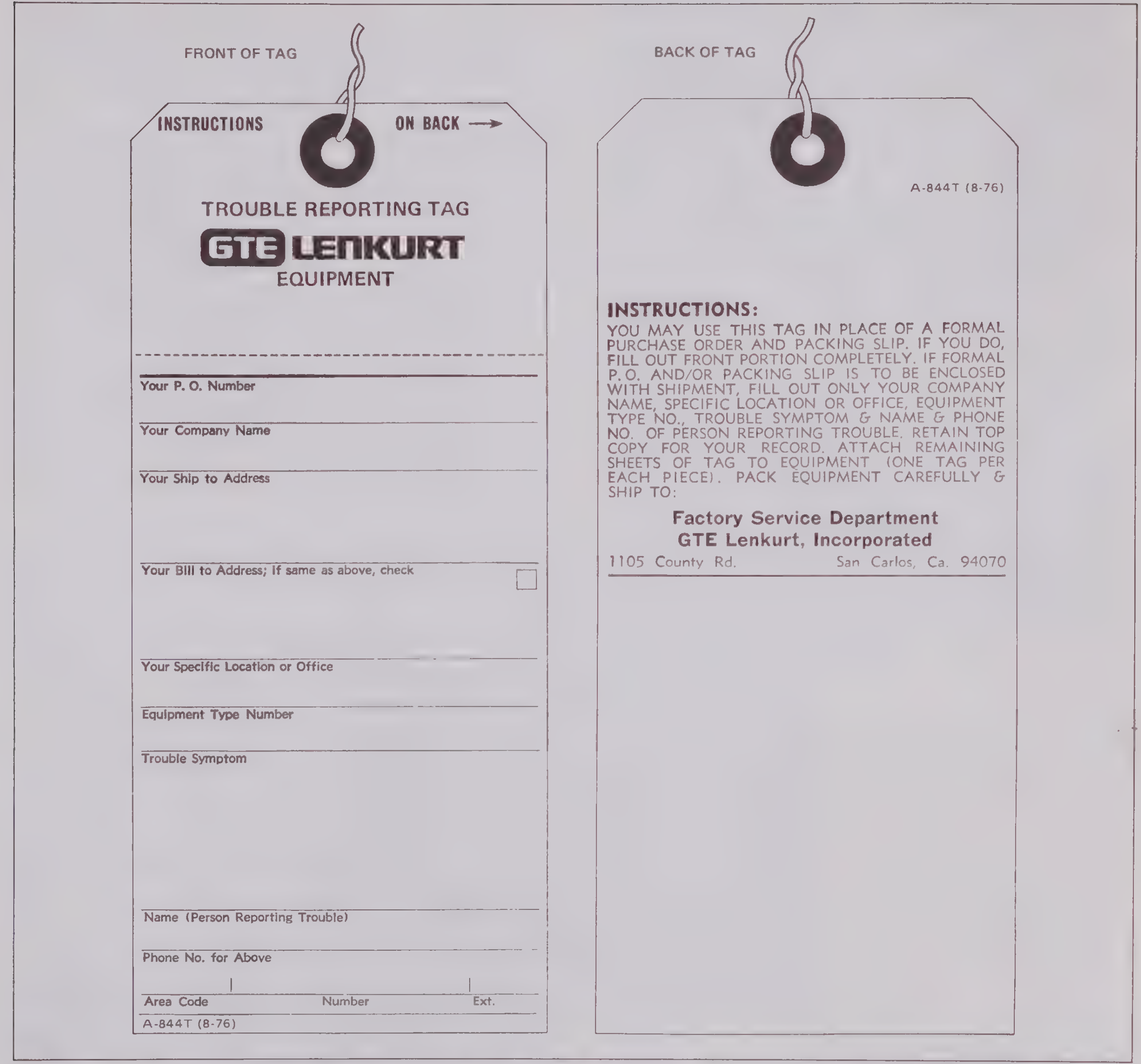
If your emergency qualifies for NEWREP service, simply telephone the GTE Lenkurt representative who handled the original equipment order or GTE Lenkurt Order Service (415–595-3000). Immediately tag the defective unit with trouble symptoms, company original order number, and include the statement "NEW EQUIPMENT DEFECTIVE—RETURNED FOR EXCHANGE." Please do not mark the unit in any way. (Note: material not properly tagged will be processed as a repair and return order.)

Ship the unit (charges prepaid) by a traceable mode to:

Factory Service Department (NEWREP)
GTE Lenkurt Incorporated
1105 County Road
San Carlos, California 94070

Critical service threatened? Then request CARE Service. We'll loan you a temporary replacement unit.

Figure 1. Trouble Reporting Tag (Form A-844T)


FRONT OF TAG
BACK OF TAG

INSTRUCTIONS ON BACK →

TROUBLE REPORTING TAG

GTE LENKURT

EQUIPMENT

Your P. O. Number

Your Company Name

Your Ship to Address

Your Bill to Address; if same as above, check ☐

Your Specific Location or Office

Equipment Type Number

Trouble Symptom

Name (Person Reporting Trouble)

Phone No. for Above

Area Code | Number | Ext.

A-844T (8-76)

A-844T (8-76)

INSTRUCTIONS:

YOU MAY USE THIS TAG IN PLACE OF A FORMAL PURCHASE ORDER AND PACKING SLIP. IF YOU DO, FILL OUT FRONT PORTION COMPLETELY. IF FORMAL P.O. AND/OR PACKING SLIP IS TO BE ENCLOSED WITH SHIPMENT, FILL OUT ONLY YOUR COMPANY NAME, SPECIFIC LOCATION OR OFFICE, EQUIPMENT TYPE NO., TROUBLE SYMPTOM & NAME & PHONE NO. OF PERSON REPORTING TROUBLE. RETAIN TOP COPY FOR YOUR RECORD. ATTACH REMAINING SHEETS OF TAG TO EQUIPMENT (ONE TAG PER EACH PIECE). PACK EQUIPMENT CAREFULLY & SHIP TO:

Factory Service Department
GTE Lenkurt, Incorporated
1105 County Rd. San Carlos, Ca. 94070

QUANTITIES OF TROUBLE REPORTING TAGS (FORM A-844T) ARE AVAILABLE UPON ORDER FROM GTE LENKURT INCORPORATED, 1105 COUNTY ROAD, SAN CARLOS, CALIF. 94070, ATTENTION: DOCUMENT CONTROL, MAIL STATION B-552

GTE LENKURT

Company Headquarters and Manufacturing Facility
1105 County Road
San Carlos, California 94070
Phone 415—595-3000

Albuquerque Manufacturing Facility
One Camino de Lenkurt
Albuquerque, New Mexico 87123
Phone 505—296-0551

El Paso Manufacturing Facility
10727 Gateway West
El Paso, Texas 79935
Phone 915—593-3400

District Sales Offices
1105 County Road
San Carlos, California 94070
Phone 415—595-3000

120 West Eastman Street
Arlington Heights, Illinois 60004
Phone 312—398-6700

542 Haggard Street, Suite 510
Plano, Texas 75074
Phone 214—422-4305

3015 Williams Drive
Fairfax, Virginia 22031
Phone 703—698-1850

5780 Peachtree-Dunwoody Road, N.E.
Suite 145
Atlanta, Georgia 30342
Phone 404—256-3000

GTE International Sales Office
1105 County Road
San Carlos, California 94070
Phone 415—595-3000
Cable: GENTELINT

910A PCM Subscriber Carrier System

1. GENERAL

1.01 This Addendum to Section 342-911-104, Issue 5, adds TB1 to the power distribution panel and a caution in paragraph 10.13. Other minor corrections are also made.

1.02 In ink or red pencil, make the changes indicated in Part 2 or write "See Addendum" in the margin adjacent to the change. File this Addendum immediately ahead of Section 342-911-104, Issue 5.

2. CHANGES

● 2.01 Page 26, paragraph 4.76, add new last sentence. "See CAUTION in paragraph 10.13."

● 2.02 Page 66, paragraph 10.04, add new last sentence to (i). "See CAUTION in paragraph 10.13."

● 2.03 Page 67, paragraph 10.13, insert following CAUTION after (c).

CAUTION: (a) Do not install a subscriber-end channel unit without also installing a companion office-end channel unit.

(b) Do not leave the office-end channel unit NORM/TEST switch in the TEST position any longer than required for testing.

(c) Omission of the office-end channel unit or leaving the switch in the TEST position operates the subscriber-end channel unit ringing relay and partially activates the ringing circuit. This circuit is designed for intermittent service. Continuous operation (for example, in a high temperature environment) could eventually lead to excessive heat buildup and possible damage to the channel unit.

● 2.04 Page 68, paragraph 10.15, add sub-paragraph (j).

(j) See CAUTION in paragraph 10.13.

● 2.05 Page 71, paragraph 10.35, add new last sentence to (d). "See CAUTION in paragraph 10.13."

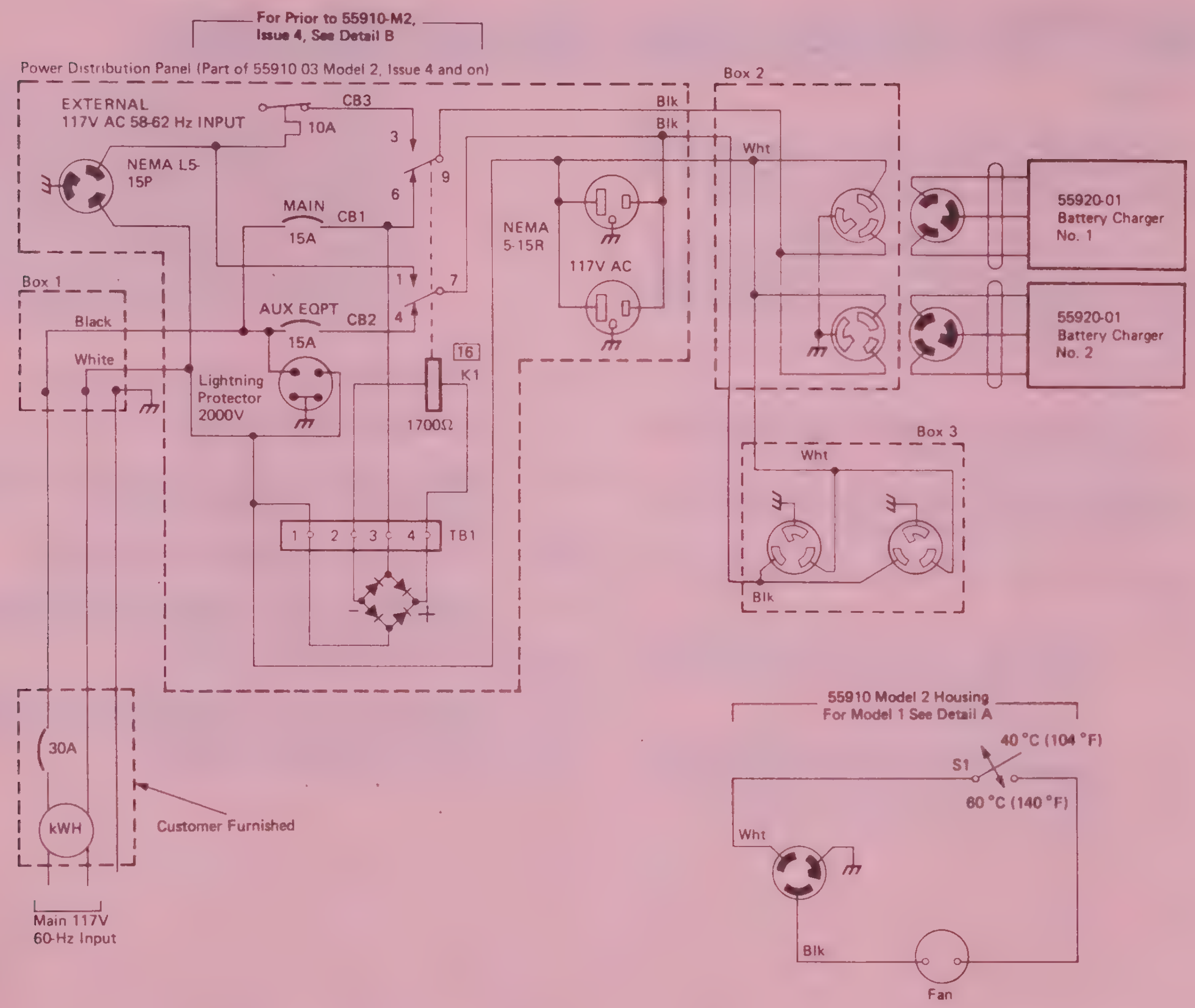
● 2.06 Page 85, figure 10-7, replace with new sheet 5.

● 2.07 Page 86, figure 10-7K, change Power Distribution Panel heading to read: "Power Distribution Panel (Part of 55910-04 Model 2, Prior to Issue 3)."

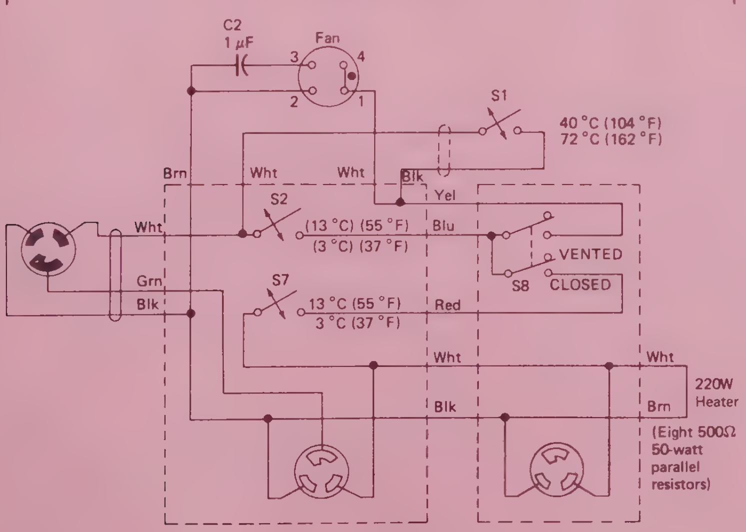
● 2.08 Page 87, figure 10-7K, change Power Distribution Panel heading to read: "Power Distribution Panel (Part of 55910-04 Model 2) $\boxed{16}$ $\boxed{17}$ $\boxed{18}$."

Figure 10-7. 910A Housing Assembly, Circuit Diagram (Sheet 5 of 8)

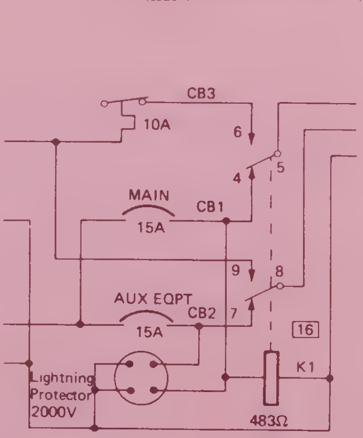
Figure J. AC Power Distribution (117V AC Primary Power)


For Prior to 55910-M2, Issue 4, See Detail B
Power Distribution Panel (Part of 55910 03 Model 2, Issue 4 and on)
EXTERNAL 117V AC 58-62 Hz INPUT
NEMA L5-15P
CB3
10A
3
9
6
MAIN
CB1
15A
1
7
AUX EQPT
CB2
4
15A
16
K1
1700Ω
Lightning Protector 2000V
NEMA 5-15R
117V AC
Blk
Blk
Wht
TB1
1 2 3 4
Box 1
Black
White
Box 2
Box 3
Wht
Blk
55920-01 Battery Charger No. 1
55920-01 Battery Charger No. 2
30A
kWH
Customer Furnished
Main 117V 60-Hz Input
55910 Model 2 Housing For Model 1 See Detail A
S1
40 °C (104 °F)
60 °C (140 °F)
Wht
Blk
Fan

Detail A. 55910 Model 1 Housing


C2
1 μF
Fan
3
4
2
1
S1
40 °C (104 °F)
72 °C (162 °F)
Brn
Wht
Wht
Blk
Yel
S2
(13 °C) (55 °F)
(3 °C) (37 °F)
Blu
VENTED
S8
CLOSED
Wht
Grn
Blk
S7
13 °C (55 °F)
3 °C (37 °F)
Red
Wht
Wht
Blk
Brn
220W Heater
(Eight 500Ω 50-watt parallel resistors)

Detail B. Prior to 55910-M2, Issue 4


CB3
10A
6
4
5
MAIN
CB1
15A
9
8
AUX EQPT
CB2
7
15A
16
K1
Lightning Protector 2000V
483Ω

910A PCM Subscriber Carrier System

APPLICATIONS

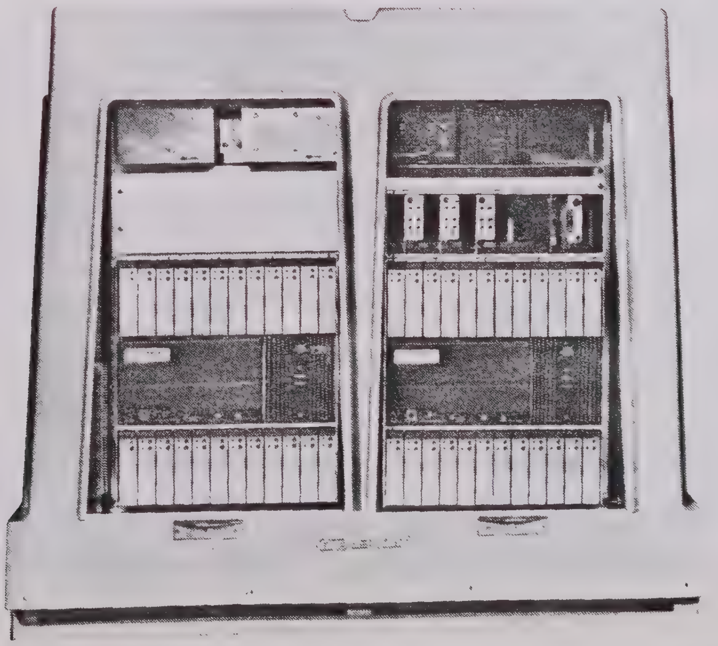
- Provides 24 or 48 single-party subscriber channels between a central office terminal and a remote terminal to expand and upgrade subscriber voice and data services.
- Allows selection of single-party or multiparty service per channel; when fully equipped with four-party channel units, one subscriber carrier system can serve up to 192 subscribers.
- Suited for special services using foreign exchange, dial pulse, or E&M signaling; may be utilized in tandem links.
- Operates with full-prepay or semi-postpay paystations.

SYSTEM FEATURES

- Advanced D3-format pcm subscriber carrier system performance meets toll connecting quality objectives.
- Uses T1-type pcm repeatered line facilities (see Sections 342-910-105 and 342-910-106). Automatic spare span line facilities for backup protection.
- Each channel provides power to ring up to four high-impedance, straight-line ringers. Signaling options for frequency selective, bridged, divided or superimposed ringing.
- Service may be converted by simply changing channel units. ANI feature provided with two-party divided ringing service.
- No adjustments required of common equipment units.

REMOTE TERMINAL HOUSING ASSEMBLY FEATURES

- Weatherproof housing with lockable covers accommodates up to 48 channels of pcm cable carrier and accessory equipment.
- Pad or platform installations.
- Thermostatically controlled fan maintains stable operating environment in protective housing.
- Operates from 117 Vac, 60 Hz, or 220 Vac, 50 Hz, power requiring 400 watts maximum for 48-channel equipment configuration.
- Batteries available for 8-hour standby protection.
- Only field wiring required is ac input power and connection of hf and vf pairs.
- Lightweight 483-mm (19-inch) aluminum racks have full front and rear access because of 160 degree rotation capability.
- Fail-safe gas tube protection provided in housing.



TECHNICAL SUMMARY

VF CHANNELS

Two-wire vf transmission:	
Transmit level	0 dBm
Receive level	0 dBm, factory set; adjustable to –3 dBm
Frequency response	200 Hz to 3400 Hz (3-dB points referenced to 1000 Hz)
Impedance	900 ohms plus 2.15 μF
Idle noise	23 dBrnc0 maximum; 16 dBrnc0 typical
Signal to quantizing noise ratio	33 dB minimum with 0 to –30 dBm0 input signal
Interchannel crosstalk	25 dBrnc0 maximum
Impulse noise	5 counts maximum in 5 minutes with 58 dBrn0 VB threshold
Echo return loss	22 dB minimum; 26 dB typical
Singing return loss	15 dB minimum; 18 dB typical
Longitudinal balance	55 dB minimum (IEEE method)
Talk/signaling battery	400 ohms resistance battery (–53 Vdc nominal for a 910A Remote Terminal Housing Assembly)

Dial pulse signaling distortion:	
Leak A with 60% break input at 12 pps	57% break output minimum (54% for 91266-03 channel unit)
Loop, 0 to 1600 ohms, with 60% break input at 12 pps	72% break output maximum (1200 ohms maximum loop for 91266-03)

Ringing:	
Voltage to office channel unit	
Bridged, divided, and paystation	75 to 165 Vac
Superimposed	84 to 88 Vac
Voltage from subscriber channel unit	130/155 volts nominal, peak to base
Frequency, office and subscriber channel units	
Bridged and divided	16-2/3 to 66-2/3 Hz
Superimposed	20 to 66-2/3 Hz
Paystation	20 to 33-1/3 Hz
Capacity	Refer to figure 5-3 for number of ringers
Ring trip	Functions in less than 250 milliseconds

CO ALARM INDICATIONS

For local terminal	System failure, blown fuse, or power failure; line failure (optional)
For remote terminal (typical)	Door open, ac failure, low battery voltage, high temperature, ringing supply failure, blown fuse

910A REMOTE TERMINAL HOUSING ASSEMBLY

Weight (approximate)	
55910 Model 1 (Manufacture Discontinued)	Basic assembly, unequipped 158.7 kg (350 pounds)
	Fully equipped, 362.9 kg (800 pounds)
55910 Model 2	Basic assembly, unequipped, 204.1 kg (450 pounds)
	Fully equipped, 408.2 kg (900 pounds)

Dimensions:	55910 Model 1 (Manufacture Discontinued)	55910 Model 2
Height	1270 mm (50 inches)	1321 mm (52 inches)
Width	1448 mm (57 inches) maximum at base	1476 mm (58-1/8 inches)
Depth	787 mm (31 inches) maximum at base	832 mm (32-3/4 inches)

Primary ac power:	
117 volts	100 to 130 Vac at 60 Hz (±2 Hz)
220 volts (option for foreign countries)	200 to 240 Vac at 50 Hz (±2 Hz)
Load without heater	400 watts
Load with heater on	600 watts (55910 Model 2 does not have a heater)

Ambient temperature range	–40°C to +60°C (–40°F to +140°F)
Maximum operating altitude	4 572 metres (15,000 feet)

REMOTE TERMINAL (48-channel, without housing)

Rack mounting spaces:	
9002B PCM Channel Banks (2)	22 spaces total
91101 Line Terminating Shelf	4 spaces
91270 Equipment Shelf	3 spaces

Weight of four items above (equipped)	113.4 kg (250 pounds)
Power (typical maximum)	5 amperes at –48 Vdc (–44 to –56 Vdc); 30 dBrnc maximum switching noise; 25 dBrnc maximum 60 Hz

TECHNICAL SUMMARY (Continued)

CENTRAL OFFICE TERMINAL (48-channel)

Rack mounting spaces:	
9002B PCM Channel Banks (2)	22 spaces total
91275 Auxiliary Alarm Panel	1 space
Weight of three items above (equipped)	90.7 kg (200 pounds)
Power (typical maximum)	3 amperes at – 48 Vdc (– 44 to – 56 Vdc)

Equipment	Rack Mtg Spaces	Equipped Weight	Max. Input at – 48
9002B PCM Channel Bank	11	45.9 kg (100 lb)	Note 1
55920 Battery Charger	Note 2	13.6 kg (30 lb)	4A at 117 Vac (-01) 2A at 220 Vac (-02)
91101 Line Terminating Shelf	4	9.1 kg (20 lb)	425 mA
91260 Bridged Ringing Subscriber Channel Unit	—	.9 kg (2 lb)	150 mA
91261 Bridged Ringing Office Channel Unit	—	.9 kg (2 lb)	43 mA
91262 Divided Ringing Subscriber Channel Unit	—	.9 kg (2 lb)	150 mA
91263 Divided Ringing Office Channel Unit	—	.9 kg (2 lb)	43 mA
91264 Superimposed Ringing Subscriber Channel Unit	—	.9 kg (2 lb)	150 mA
91265 Superimposed Ringing Office Channel Unit	—	.9 kg (2 lb)	43 mA
91266 Full-Prepay Subscriber Channel Unit	—	.9 kg (2 lb)	150 mA
91267 Full-Prepay Office Channel Unit	—	.9 kg (2 lb)	43 mA
91268 Semi-Postpay Subscriber Channel Unit	—	.9 kg (2 lb)	150 mA
91269 Semi-Postpay Office Channel Unit	—	.9 kg (2 lb)	43 mA
91270 Equipment Shelf	3	11.3 kg (25 lb)	— — —
91271 Fuse and Alarm Unit	—	.9 kg (2 lb)	80 mA
91272 Power Supply Unit	—	3.6 kg (8 lb)	2.3A (Full load. Current limited mode.)
91275 Auxiliary Alarm Panel	1	.7 kg (1-1/2 lb)	170 mA
T8T Power Converter (Lorain)	2	8.6 kg (19 lb)	1A
1CRR15 20-Hz Ringing Generator (Warren)	2	11.3 kg (25 lb)	0.7A

Rechargeable Battery, stock no. 149-54139-01 Size: 127 mm x 175 mm x 168 mm (5" x 6-7/8" x 6-5/8"); 7.7 kg (17 lb)

Notes:

1. Maximum input at – 48 Vdc to channel bank is 0.8 amperes plus current listed for applicable channel units.
2. Two 55920 Battery Chargers are mounted side by side in three rack mounting spaces.

GTE Lenkurt may change performance specifications where necessary to meet industry requirements.

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CD = Circuit Diagram

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1. GENERAL

1.01 This Section describes the 910A PCM Subscriber Carrier System, including the 910A Remote Terminal Housing Assembly and the subscriber application of the 9002A or 9002B PCM Channel Bank. (9002B supersedes 9002A.) The Section covers functional operation, engineering considerations, ordering information, installation, and maintenance. ▶Associated GTE Practices are listed in figure 1-1. As noted in figure 1-1, the 9104A system GTEPs supersede the 9101C system GTEPs.◀

1.02 The equipment covered in this Section is the latest model as of the publication date. Later models are capable of greater application or are more effective in performance of their functions than earlier models. A later model supersedes an earlier model and may always be substituted for an earlier model provided the type number is not changed. Necessary information pertaining to earlier models and to the 9002A channel bank is retained in the applicable parts of the Section.

▶1.03 Issue 5 of this Section incorporates Addendum 342-911-104 Issue 2. The addendum changes are as follows:

(a) Adds information on the -03 and -04 options of the 91232 Test and Alignment Set and the -02 option of the 91270 Equipment Shelf.

Figure 1-1. Associated Publications

GTE Section	Title
032-201-150	GTE Lenkurt Test Cords, Plugs, and Adapter Assemblies
108-402-504	26600 Model 1 Test Set Procedures
108-402-106	26600 Model 2 Test Set
342-910-103	[1] 9101C PCM Repeatered Line Equipment
342-910-105	[1] 9104A PCM Repeatered Line Inside Plant Equipment
342-910-106	[1] 9104A PCM Repeatered Line Outside Plant Equipment
342-910-114	91A Spare Line Transfer Equipment
342-911-103	9002A PCM Channel Bank
342-911-107	9002B PCM Channel Bank
342-911-110	9002A/B PCM Channel Bank Equipment Compatibility
476-201-100	Telephone Coin GTE Automatic Electric Single Slot — Type 120A — Description & Installation
836-910-072	9101C Engineering
836-910-081	9104A Engineering
992-600-003	Repair and Return, GTE Lenkurt Equipment

Note: [1] The 9104A System supersedes the 9101C System. ◀

(b) Adds -02 option of the 91272 Power Supply Unit.

(c) Provides instructions for the installation of "Code A" in the 91266 channel unit.

(d) Adds -03 option of the 91114 Office Fault Locating Filter Unit.

1.04 Other changes are:

(a) Deletes -02 option of 91266 channel unit.

(b) Manufacture discontinues -01 option of the 91114 unit.

(c) Adds information on 91266-01 channel unit interface with GTE Automatic Electric paystations.

(d) Document changes effective with issue 3 and 4 of 55910-M2 housing.

(e) Makes miscellaneous other changes.

1.05 Significant changes and additions are marked with marginal arrows. Remove the previous issue and Addendum of this Section from the binder or microfiche file and replace it with this issue.◀

2. DESCRIPTION

2.01 The subscriber carrier system consists of a central office terminal and a remote terminal linked by 1.544-Mb/s repeatered lines. The system extends 24 or 48 single-party subscriber channels from a central office (CO) or community dial office (CDO). It also provides multiparty, paystation, or special-service facilities.

2.02 Each 24-channel system requires two span lines, one for each direction of transmission. In the optional arrangement of figure 2-1, one set of spare span lines provides a backup for both systems with failure of a working span line in either direction causing automatic transfer of the system to the spare set. One or two pairs (depending on system length) are used for fault locating and another pair, if necessary, for an order wire; loaded pairs are recommended for lengths exceeding 5 486 m (18 kilofeet).

910A Remote Terminal Housing Assembly

2.03 The 910A housing assembly (see cover page) is a weatherproof shelter containing the basic equipment for a 48-channel remote terminal. It includes channel banks, line terminating shelf, power supplies, battery chargers, batteries (optional), and auxiliary equipment. Plug-in units are installed according to the number of subscriber loops. Four rack mounting spaces are available for optional equipment.

2.04 The housing assembly, which can be mounted on a concrete pad or on a wooden platform between two poles, consists of three main components: base, two-rack frame on which the equipment is mounted, and the housing. Service access to the housing is through two 533- by 864-mm (21- by 34-inch) doors on the front. The two racks can be pivoted 160 degrees for access to the rear of the equipment.

2.05 The 55910 Model 2 housing is made of fiberglass and has increased insulation. Suitable operating temperature is maintained by a thermostatically controlled fan. The 55910 Model 1 housing (manufacture discontinued) maintains proper operating temperature by means of a thermostatically controlled fan and heaters. Both housings will maintain suitable operating temperatures for the equipment over a wide range of outside ambient temperatures ranging from −40°C to +60°C (−40°F to +140°F). If the internal temperature reaches approximately +80°C (+176°F), a separate thermostat switch (S3) operates to interrupt dc power to all the loads.

2.06 All internal wiring is installed at the factory. Field wiring consists of connecting the span cable (repeatered lines, order wire, and fault locating pairs), the subscriber loops, and the ac service.

2.07 From customer-furnished ac power (117 volts at 60 Hz or 220 volts at 50 Hz), dc operating power at 48 volts is produced by two 55920 Battery Chargers. Usually, an 8-hour standby battery is floated across the 48-volt bus. An input receptacle is provided for connection to an emergency ac generator in case of prolonged primary ac power failure.

9002B PCM Channel Bank

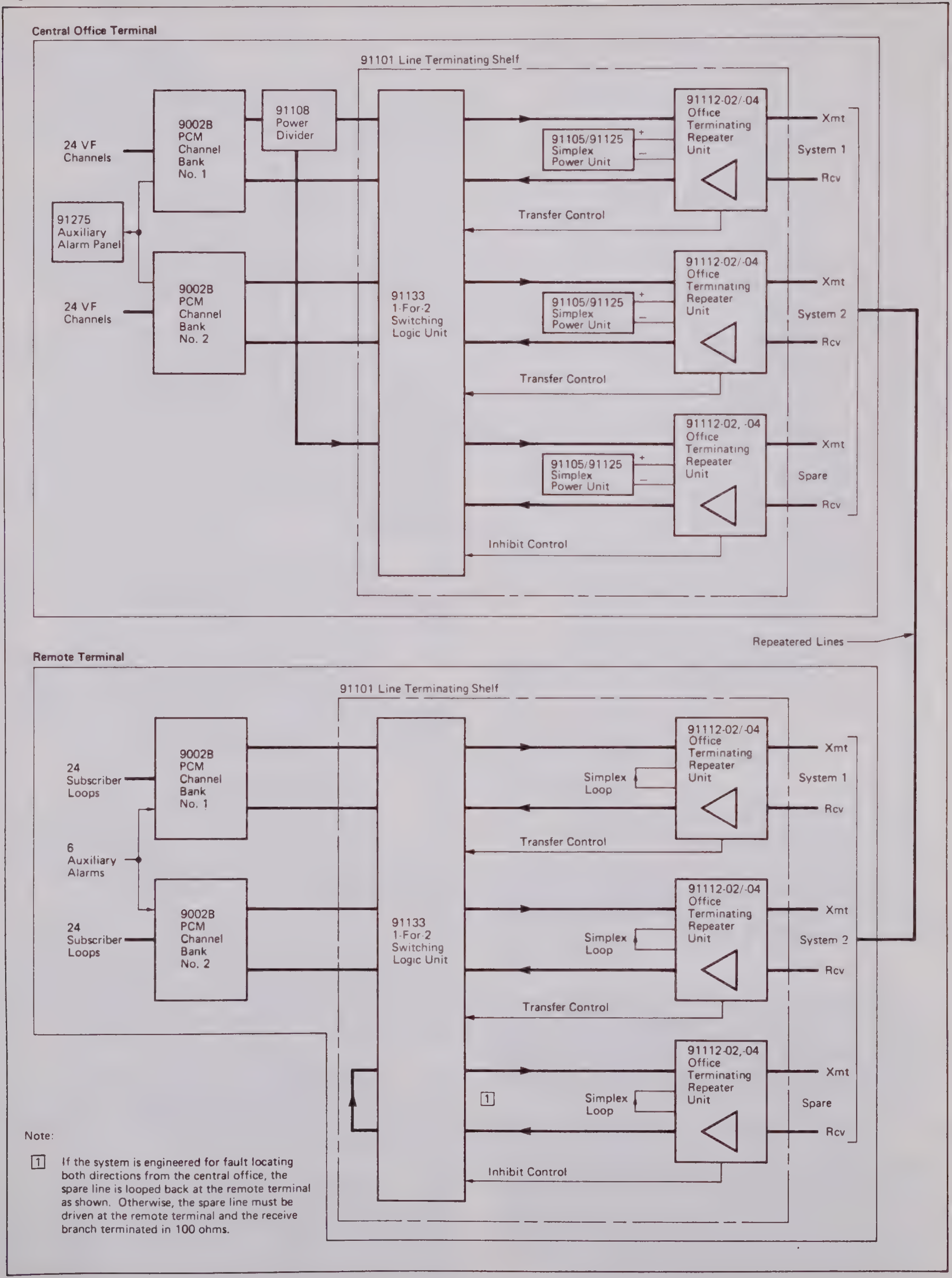
2.08 In the transmit direction, the 9002B PCM Channel Bank multiplexes the information (voice, signaling, and supervision) on 24 vf channels into a 1.544-Mb/s pulse code modulated signal. In the receive direction, it performs the reciprocal process.

2.09 Common equipment for the channel bank is the same when used for toll, toll-connecting, or subscriber applications. Standard 9002B channel units (foreign-exchange, dial pulse, and E&M) may be used, but for most applications, the channel units will be those particularly designed to provide the signaling and supervision required for subscriber and paystation service.

2.10 Ringing. Ringing information is transmitted from the central office via the vf and signaling paths of the channel. At the remote terminal,the receive branch of the channel unit applies interrupted dc (modified square wave) at the ringing frequency to the subscriber loop.

2.11 In divided ringing, the identification of the called party (tip or ring) is sent from the central office over a signaling path of the system channel. In the remote channel unit, the ringing circuit is connected between ground and the tip or ring of the pair, as applicable. In the remote-to-CO direction, the tip-party off-hook ANI (automatic number identifica-

Figure 2-1. Subscriber Carrier System Using Optional Spare Line Switching


Central Office Terminal
91101 Line Terminating Shelf
24 VF Channels
9002B PCM Channel Bank No. 1
91108 Power Divider
91112-02/-04 Office Terminating Repeater Unit
91105/91125 Simplex Power Unit
+
–
Xmt
System 1
Rcv
91275 Auxiliary Alarm Panel
Transfer Control
24 VF Channels
9002B PCM Channel Bank No. 2
91133 1-For-2 Switching Logic Unit
91112-02/-04 Office Terminating Repeater Unit
91105/91125 Simplex Power Unit
Xmt
System 2
Rcv
Transfer Control
91112-02, -04 Office Terminating Repeater Unit
91105/91125 Simplex Power Unit
Xmt
Spare
Rcv
Inhibit Control
Repeated Lines
Remote Terminal
91101 Line Terminating Shelf
24 Subscriber Loops
9002B PCM Channel Bank No. 1
91112-02/-04 Office Terminating Repeater Unit
Simplex Loop
Xmt
System 1
Rcv
Transfer Control
6 Auxiliary Alarms
24 Subscriber Loops
9002B PCM Channel Bank No. 2
91133 1-For-2 Switching Logic Unit
91112-02/-04 Office Terminating Repeater Unit
Simplex Loop
Xmt
System 2
Rcv
Transfer Control
91112-02,-04 Office Terminating Repeater Unit
1
Simplex Loop
Xmt
Spare
Rcv
Inhibit Control

Note:

1 If the system is engineered for fault locating both directions from the central office, the spare line is looped back at the remote terminal as shown. Otherwise, the spare line must be driven at the remote terminal and the receive branch terminated in 100 ohms.

tion) ground is detected and sent over a signaling path to the central office where a simplex resistance ground is applied for tip-party identification.

2.12 VF Transmission. The nominal vf transmission loss for the two-wire channel units is 0 dB (adjustable to 3 dB). A loaded 1600-ohm at 20°C (68°F) conductor loop adds about 7-dB net loss. All subscriber channel units are factory adjusted for 0-dB (±0.5) net loss and usually will not require field adjustment except on special subscriber loops.

2.13 Paystation Units. Coin-control information is transmitted over the signaling paths of the channels. At the remote end, full-prepay coin-control voltages of +130V or −130V are applied between the pair and ground or tip and ground. Paystation channel units may be used with single-slot or multislot instruments having rotary or touch-calling dials; coin-first or dial-tone-first (including coin-free emergency) options are available. Semi-postpay operation with reverse-battery supervision is also available. These single-party units may also be used for hotel/motel lines requiring message metering. See paragraph 8.18 for paystation strapping.

2.14 Remote Channel Tests. Subscriber and paystation channel units are designed for remote-looped testing. In TEST position, the NORM/TEST switch on the CO channel unit makes the channel busy toward the CO and, over a signaling path, conditions the vf and loop sensing circuits on the remote channel unit so that two-way transmission loss tests and approximate loop pulsing tests can be made from the CO end.

2.15 Auxiliary Alarms. Incoming to the CO, a signaling path of all channel units (except full-prepay) is dedicated to the transmission of auxiliary alarm indications from the remote terminal. This does not in any way interfere with normal usage of the channel for voice transmission or signaling. Six functions are normally monitored at the 910A housing assembly, and the alarm indications (one per channel) are transmitted to the CO over preassigned channels.

2.16 System Alarm. When a system alarm occurs, CO loops will be opened and auxiliary alarms will be forced to non-alarm indications. A call from a connector will ring into the CO channel unit but the ringing cannot be tripped for answer supervision. At the remote end, subscribers will receive talk battery but no dial tone; ringing will be inhibited.

---

3. FUNCTIONAL OPERATION

910A Remote Terminal Housing Assembly

3.01 Circuits of the 910A housing assembly are illustrated separately by function in figure 10-7 and described in the following paragraphs. For continuity of circuits through the 9002A or 9002B PCM Channel Bank and units of the 91101 Line Terminating Shelf, refer to GTEP Sections 342-911-103 or -107 and 342-910-103 or -105, respectively.

3.02 HF Line Circuits. (See figure 10-7A.) Repeatered lines (transmit and receive) pass through the 91101 shelf. The working systems terminate at the channel banks and the spare lines are looped back, receive to transmit. Automatic switching is controlled by error detectors on the 91112 repeater units. Failure of the incoming signal on a working system causes the 91133 unit to switch the channel bank to the spare set of repeatered lines. If the spare line fails, the error detector on the 91112 repeater unit inhibits switching.

3.03 If the system is not engineered for fault locating both directions from the central office, the spare line must be driven by a 91113 Bridging Repeater Unit at the remote terminal. The 91113 unit is installed in position J8 of the 91101 shelf and wired to the 91133 unit as shown in figure 10-8.

3.04 Quasi-Sectional Spare Line Switching. In quasi-sectional spare line switching, as explained in Section 342-910-103 or 342-910-114, one set of spare lines is shared by more than one remote terminal along the same cable route. When a working line fails, the spare lines are seized at the CO and remote terminals of the failed system. (Any unused sections of the spare line are not available in case of a second failure farther out, however.) For this application, at intermediate locations along the route, a 91112 repeater unit is installed in position J8 of the 91101 shelf and wiring is modified as shown in figure 10-9.

3.05 With the spare lines looped back at the most distant location, the fault locating outputs (pin 28) of the 91112 repeater units in positions J6 and J8 at an intermediate location would interfere if both were connected to the same 91114 filter unit. This is the reason J8-28 is grounded in figure 10-9.

3.06 At the most distant location, the single set of spare lines can be shared by two or three colocated remote housings. As shown in figure 10-10, the spare lines and an inhibit control lead are run between housings. Wiring of the 91101 shelf at position J10 is modified to interlock the 91133 units and give the highest priority to systems that terminate in the first housing. A 91112 repeater unit is required only in position J6 of the first housing.

3.07 Fault Locating. (See figure 10-7A.) In the fault locating procedure, interrogating signals are transmitted from the central office over the repeatered lines. The fault locating outputs of the 91112 repeater units are connected through the 91114 filter unit to one of the two fault locating pairs. With the 91114-02 unit (no amplifier), the audio frequency output of the filter can be connected through a switch to either pair. With the 91114-01 unit (includes an ▶amplifier), pair 1 or pair 2 is selected by strapping. (The -01 option of the 91114 unit is now manufacture discontinued.)◀

3.08 Order Wire. (See figure 10-7A.) The order wire pair is accessible through ORDER WIRE & PHONE jack J5 by a hand test telephone (butt-in) or by a customer-furnished telephone set mounted at the side of rack 2 and wired to PHONE jack J6. If the order wire pair is sectionalized by capacitors at a repeater housing, talk battery can be obtained by patching to the 2W MON pin jacks on the channel unit of a channel not wired to office switching equipment. If the order wire pair is sectionalized at a repeater housing, but capacitors are not installed; the telephone set can be patched from J6 to the 2W MON pin jacks of a carrier channel that has been assigned to a linefinder at the central office. Or, by patching from J5 instead, a dial line will be provided at repeater housings on the remote section of the order wire pair.

3.09 Line Repeater Power. (See figure 10-7C.) Unless the span length requires power feed from both ends, the span line is powered from the central office, and simplex current is looped back at the remote terminal through a 10-ohm resistor. Current can be determined by measuring the voltage drop across this resistor. If power must also be fed from the remote terminal, 91105 units are installed and the strap between pins 26 and 28 is removed on J1, J3, and J5 of the 91101 shelf.

3.10 VF Circuits. (See figure 10-7D.) From the channel banks, two-wire subscriber circuits are factory-wired to the equipment side of the 50-pair vf protector block via two 25-pair cables. Protectors are plug-in modules containing two 470-volt gas tubes. The wire-wrap terminals on the line side of the protector block are to be cabled to a locally provided external cross-connect cabinet; there, the station installer can easily rearrange circuits without opening the housing.

3.11 Auxiliary Alarms. (See figure 10-7F.) Auxiliary alarm leads AA-1 through AA-6 are factory-connected to corresponding channel units of the two systems for redundancy. Each monitored function grounds the associated auxiliary alarm lead in the normal condition. For the auxiliary alarms to be operational, subscriber channel units 1 through 6 must be installed in either or both channel banks. These channel units must be other than type 91266.

3.12 DC Power Distribution. (See figure 10-7G and 10-7H.) From the charger, 48-volt dc power (nominally −53 volts) is distributed through the 91271 unit on the 91270 shelf. The 91272 unit in position J2 produces voltages for coin control (−130V and +130V) and ringing (−260V or −310V). An optional 91272 unit in position J3 can be added to power the line repeaters at 260V (+130V and −130V) or at 310V (+180V and −130V) by using the modification of figure 10-11. Functioning of units of the 91270 shelf is described in more detail beginning at paragraph 3.28.

3.13 5920 Battery Charger. Elements of the charger (figure 10-7M) are a ferro-resonant transformer, a rectifier, and a filter. The transformer converts the ac line voltage to the desired level, regulates the dc output voltage, and limits load current. The charger will deliver regulated voltage despite changes in line voltage, load current, and ambient temperature. The charger output varies from 56 volts at 0 amperes to 53 volts at 4 amperes. At the maximum current of 6 amperes the output is 48 volts. Charger outputs are paralleled in the 91271 unit for a 12-ampere load capacity.

3.14 Battery. When 8-hour standby power is required, parallel sets of four series-connected 12-volt gelled-electrolyte batteries are floated across the 48-volt bus. According to the load, one or two sets are used (Model 1 housing may have three sets). Each set of these batteries has a 20 ampere-hour capacity. The 12-volt battery is a sealed unit containing gelled electrolyte; water or electrolyte is never added. Exposure to low temperature will not damage the battery and, as used in the 910A housing assembly, there is no danger of excessive charging or discharging. For alternate automotive-type batteries, see paragraph 5.12.

3.15 91101 Line Terminating Shelf. The dc power distribution within the 91101 shelf is shown in figure 10-7L. Unit mounting spaces at J7, J8, J9, and J12 are normally unoccupied; power is strapped through on the connector at J12. Wiring shown for −48V, −130V, and +130V fuse alarms is standard for this shelf but is not used in the 910A housing assembly.

3.16 117-Volt AC Power Distribution. As shown in figure 10-7J, the customer-furnished 117-volt ac power goes through circuit breaker CB1 to the 55920 Battery Chargers and through CB2 to the convenience outlets and fan. On the 55910 Model 1 housing, the customer-furnished 117-volt ac power also goes through CB2 to a heater in addition to the outlets and fan. The two distribution circuits are completed through contacts of normally operated relay K1. Note that opening CB1 releases K1, breaking both circuits.

3.17 Emergency power from an external ac generator can be supplied to the housing through a receptacle on the power distribution panel. Thermal overload switch CB3 protects the chargers, which may draw excessive current if the generator frequency exceeds 63 Hz. The receptacle is a twist-lock type with male contacts. A mating female plug, NEMA (National Electrical Manufacturer's Association) type L5-15R, is furnished with the 910A housing assembly.

3.18 On the 55910 Model 2 housing, a fan is plugged into a 117-volt ac receptacle on box 3. The fan is controlled by thermostat S1 at the top of rack 1. The fan turns on at 60°C (140°F) and off at 40°C (104°F).

3.19 On the 55910 Model 1 housings, a fan and 220-watt heater are plugged into a 117-volt ac receptacle on box 3. Controlled by thermostat S1 at the top of rack 1, the fan turns on at 72°C (162°F) and off at 40°C (104°F). Additionally, if switch S8 is set at CLOSED, both the fan and heater turn on if the battery compartment temperature decreases to 2.8°C (37°F), then turn off when the temperature reaches 12.8°C (55°F).

3.20 220-Volt AC Power Distribution. The distribution circuits for primary ac power at 220 volts and 50 Hz (figure 10-7K) are similar to those described for 117 volts except there is only one circuit breaker. Convenience outlets and battery chargers (55920-02) are connected to the 220-volt distribution, but the fan is supplied with 110 volts by 1000-watt autotransformer T1. Heaters are also furnished with the 55910 Model 1 housings and are supplied with 110 volts by autotransformer T1.

Remote Terminal, Office Installation

3.21 The remote terminal may be rack mounted and installed in a telephone office. Typical rack profiles are illustrated in figure 6-7. Circuits previously described for the 910A housing assembly will be applicable, particularly for a 48-channel terminal. For installations using the 91155 Fuse and Alarm Shelf, refer to Section 342-910-103 or 342-910-105.

Central Office Terminal

3.22 Except for the subscriber-type channel units and the 91275 Auxiliary Alarm Panel described in this Section, the central office terminal is a standard application of the 9002B PCM Channel Bank and the 9101C PCM Repeatered Line Equipment. Typical rack layouts are shown in figure 6-7.

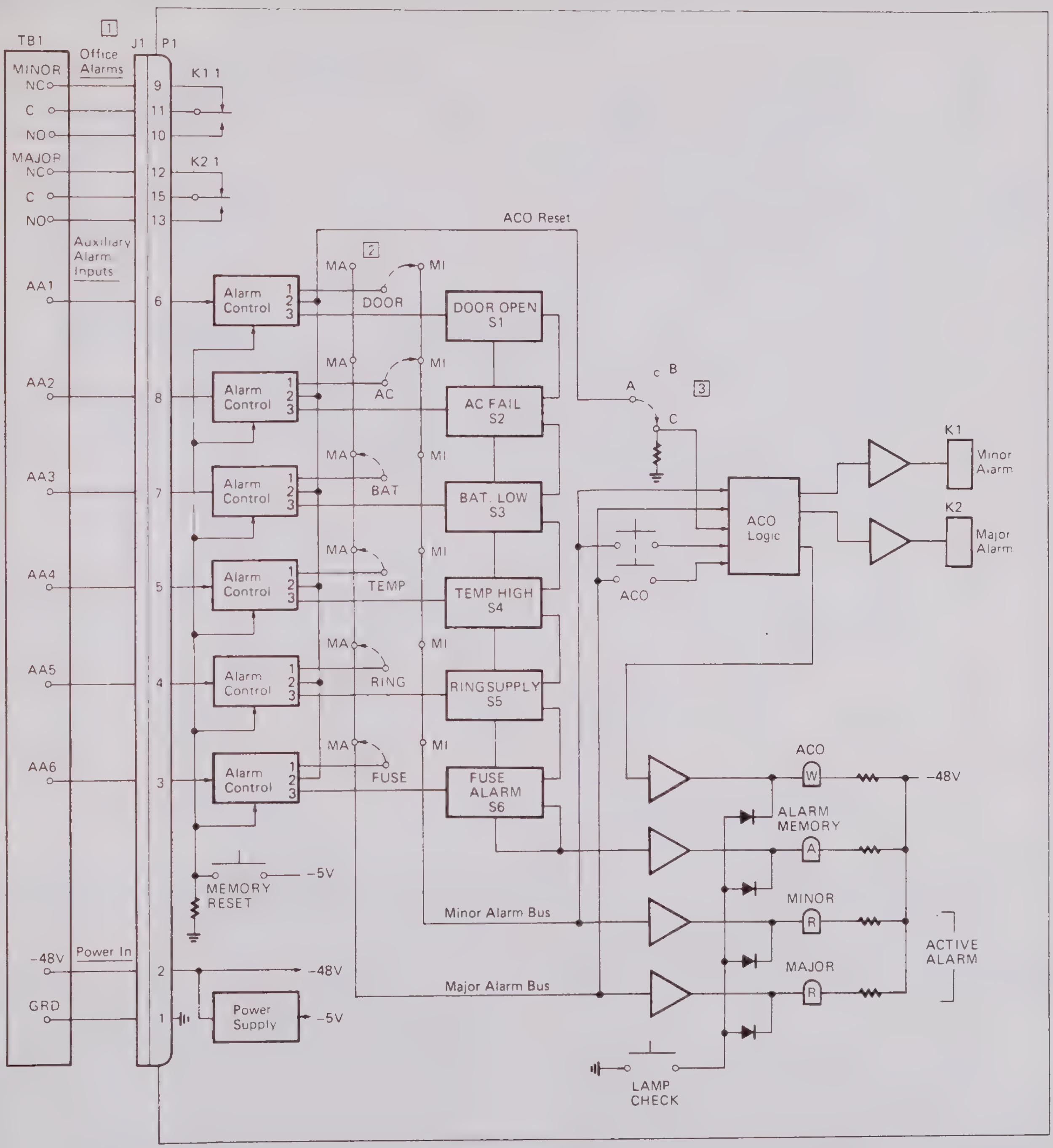
91275 Auxiliary Alarm Panel

3.23 At the central office, the alarm states of six functions at the remote terminal (battery voltage, for example) are received on the signaling paths of 12 channel units, one per function in each channel bank. When a function goes into alarm, both of the associated CO channel units ground the AA lead to an alarm control circuit in the 91275 panel (figure 3-1). After a 200-millisecond delay (approximate) that prevents response to transient conditions, ground (±1 volt) on the AA lead causes the three outputs of the alarm control circuit to change state.

3.24 Output 1 of the alarm control circuit, which is strapped to one of the two alarm buses, goes to logic 0 (−5 volts), lighting an ACTIVE ALARM lamp (MINOR or MAJOR) and operating alarm relay K1 or K2. At output 3, a storage flip-flop in the alarm control circuit applies logic 0 through six pushbuttons (S1 through S6) to light the ALARM MEMORY lamp.

3.25 Pushing the automatic cut off button (ACO) releases the alarm relay, latches out both alarm relays, and lights the ACO lamp. If A is strapped to B, the alarm relays will not operate again if a second alarm occurs before the first has cleared. But if A is strapped to C, a logic 0 pulse from output 2 of the second alarm control circuit will reset the alarm control logic, allowing the applicable alarm relay to operate.

Figure 3-1. 91275 Auxiliary Alarm Panel, Circuit Diagram


TB1
1
Office Alarms
J1
P1
MINOR
NC
C
NO
MAJOR
NC
C
NO
K1 1
K2 1
9
11
10
12
15
13
Auxiliary Alarm Inputs
AA1
AA2
AA3
AA4
AA5
AA6
6
8
7
5
4
3
Alarm Control
1 2 3
ACO Reset
2
MA
MI
DOOR
AC
BAT
TEMP
RING
FUSE
DOOR OPEN S1
AC FAIL S2
BAT. LOW S3
TEMP HIGH S4
RING SUPPLY S5
FUSE ALARM S6
A
B
C
3
ACO Logic
ACO
K1
Minor Alarm
K2
Major Alarm
MEMORY RESET
−5V
Minor Alarm Bus
Major Alarm Bus
−48V
GRD
Power In
2
1
Power Supply
−48V
−5V
ACO
W
ALARM MEMORY
A
MINOR
R
MAJOR
R
−48V
ACTIVE ALARM
LAMP CHECK

Notes:

1. External Connections. Cable assembly 11 inches long, including TB1 and J1, is furnished with 91275 panel. Mount TB1 on back of rack. Make external connections to wire-wrap terminals on TB1.

2. Minor/Major Alarm. Strap six alarm functions to minor alarm bus (MI) or major alarm bus (MA) as required. Factory strapping is shown.

3. ACO Reset. Strap ACO reset circuit as required. Factory strapping is shown.

Strap A-B	Alarm relays are disabled by ACO switch for duration of an active alarm condition.
Strap A-C	Alarm relays are disabled by ACO switch after an initial active alarm but operate when a second alarm occurs before the first has cleared.

4. Model 1 of the 91275 Panel. This diagram shows the circuits and optional strapping of the model 2 panel. The model 1 panel is the same except as follows:

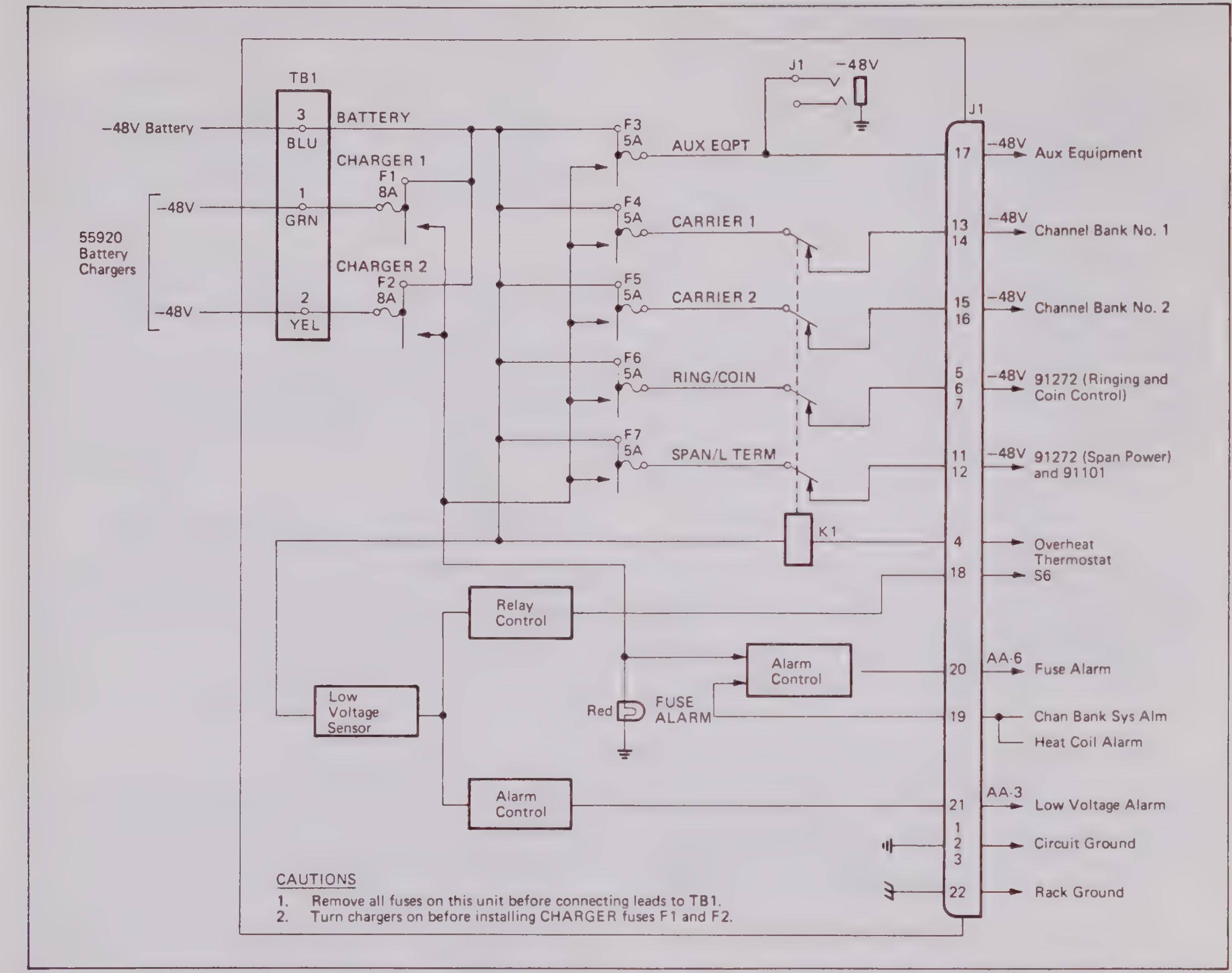
   a. Separate minor and major alarm indications are not provided. There is one ACTIVE ALARM lamp and one alarm relay (K1).

   b. Movable contact of relay K1 is connected to pin 12 instead of pin 11.

   c. ACO reset feature is not provided.

   d. Optional strapping described in Notes 2 and 3 is not applicable.

Figure 3-2. 91271 Fuse and Alarm Unit, Circuit Diagram


TB1
−48V Battery
3
BLU
BATTERY
55920
Battery
Chargers
−48V
1
GRN
CHARGER 1
F1
8A
−48V
2
YEL
CHARGER 2
F2
8A
J1
−48V
F3
5A
AUX EQPT
F4
5A
CARRIER 1
F5
5A
CARRIER 2
F6
5A
RING/COIN
F7
5A
SPAN/L TERM
K1
J1
17
−48V
Aux Equipment
13
14
−48V
Channel Bank No. 1
15
16
−48V
Channel Bank No. 2
5
6
7
−48V
91272 (Ringing and
Coin Control)
11
12
−48V
91272 (Span Power)
and 91101
4
Overheat
Thermostat
S6
18
Relay
Control
Alarm
Control
20
AA-6
Fuse Alarm
Low
Voltage
Sensor
Red
FUSE
ALARM
19
Chan Bank Sys Alm
Heat Coil Alarm
Alarm
Control
21
AA-3
Low Voltage Alarm
1
2
3
Circuit Ground
22
Rack Ground
CAUTIONS
1. Remove all fuses on this unit before connecting leads to TB1.
2. Turn chargers on before installing CHARGER fuses F1 and F2.

3.26 When the monitored function returns to normal, the CO channel units remove ground from the AA lead, restoring output 1 of the alarm control circuit to logic 1 (ground). If there are no other alarms on the same bus, the applicable ACTIVE ALARM lamp goes out. If there are no alarms on either bus, the latch is removed from relays K1 and K2.

3.27 Functions that have a previous alarm or an active alarm can be identified by pushing the alarm buttons, one at a time. As each button is pushed, output 3 of the associated alarm control circuit is connected directly to the alarm memory circuit input. If the flip-flop controlling output 3 is set, the ALARM MEMORY lamp will stay lighted. Otherwise, it will go out. Pushing the MEMORY RESET button resets the flip-flops in the alarm control circuits and, if there are no active alarms, the ALARM MEMORY lamp will go out.

91270 Equipment Shelf

3.28 At a remote terminal, the 91270 shelf is usually equipped with a 91271 Fuse and Alarm Unit and one or two 91272 Power Supply Units. The 91271 unit plugs into the front left-hand mounting position (J1); the 91272 units plug into the center and right-hand positions (J2 and J3).

3.29 91271 Fuse and Alarm Unit. The 91271 unit distributes −48 volts (nominally −53 volts) to the remote terminal equipment as shown in figure 3-2. When used, two 55920 Battery Chargers are connected to the 48-volt battery through fuses on the 91271 unit.

3.30 Alarms resulting from a blown fuse or low battery voltage (44 volts) are transmitted to the central office and appear there on the 91275 Auxiliary Alarm Panel. In the event of ac power failure, the low-voltage alarm occurs after about 6 hours of battery usage and warns of an imminent need for emergency ac power at the remote terminal. If the battery discharges to approximately 36 volts, relay K1 disconnects four of the five distribution circuits to prevent damage to the battery and to the terminal equipment. When ac power has been restored and the bus voltage is about 47 volts, relay K1 will operate and restore dc power to the terminal equipment.

3.31 91272 Power Supply Unit. From a −48 volt input, the 91272 unit (figure 3-3) produces two floating dc outputs (130V and 130V/180V) and one −130V output. The −130V output is obtained by connecting a 79-volt supply generated in the 91272 unit in series with the external −48 volt supply, which is typically −51 to −53 volts.

3.32 In the center shelf mounting position J2 of a 910A housing assembly, a 91272 unit is connected as shown in figure 3-3C. Here, the two 130V outputs are used for paystation coin control and the 130V/180V output is connected in series with −130V to form a −260V/−310V ringing supply. Loads are intermittent and variable as indicated symbolically

Figure 3-3. 91272 Power Supply Units, Circuit Diagram (Sheet 1 of 2)

Figure A. 91272-01 Power Supply Unit

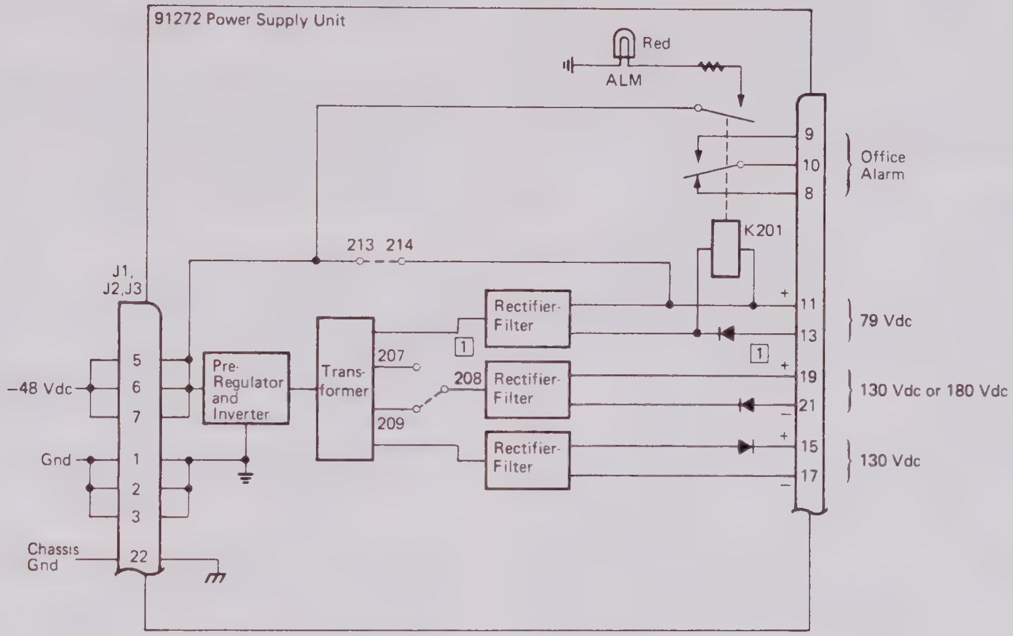

91272 Power Supply Unit
Red
ALM
9
10
8
Office Alarm
K201
213
214
J1, J2,J3
+
11
13
79 Vdc
Rectifier-Filter
1
1
Trans-former
207
208
209
Rectifier-Filter
19
21
130 Vdc or 180 Vdc
Rectifier-Filter
15
17
130 Vdc
Pre-Regulator and Inverter
–48 Vdc
5
6
7
Gnd
1
2
3
Chassis Gnd
22

Figure B. 91272-02 Power Supply Unit

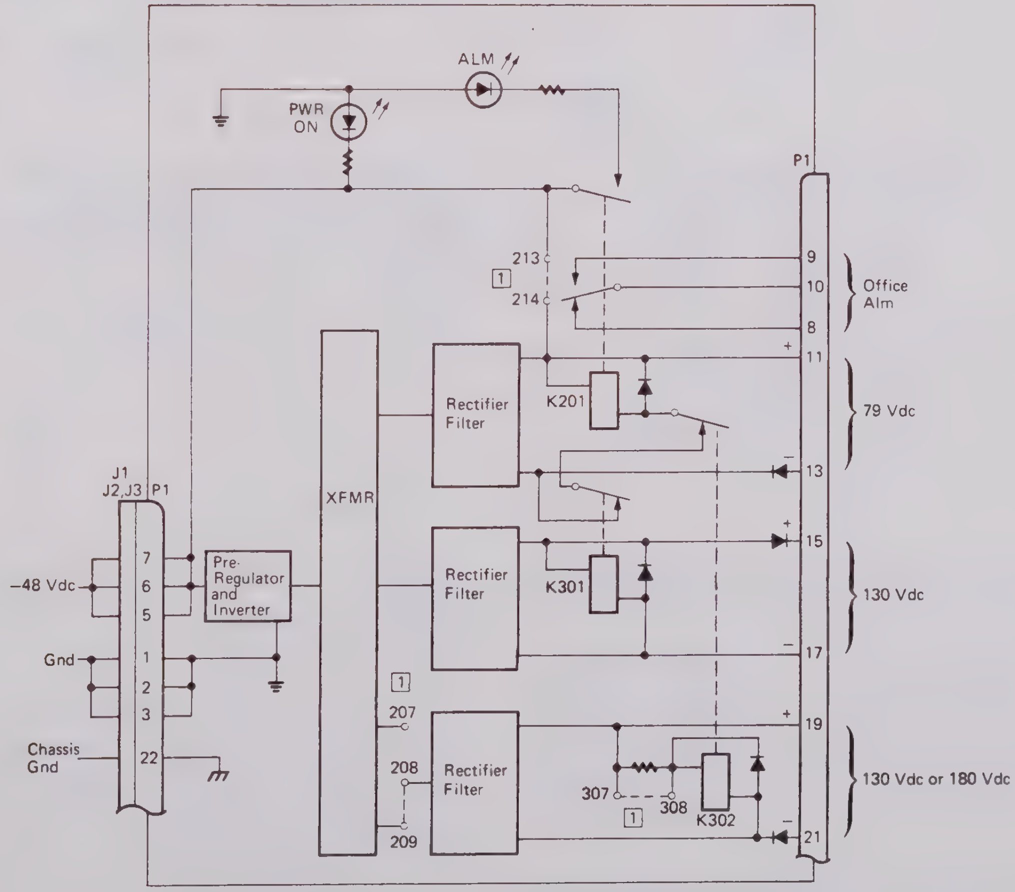

ALM
PWR ON
P1
213
1
214
9
10
8
Office Alm
+
11
K201
Rectifier Filter
79 Vdc
13
XFMR
J1 J2,J3
P1
7
6
5
–48 Vdc
Pre-Regulator and Inverter
Rectifier Filter
K301
+
15
130 Vdc
17
Gnd
1
2
3
1
207
Chassis Gnd
22
208
Rectifier Filter
209
307
308
1
K302
19
21
130 Vdc or 180 Vdc

Figure 3-3. 91272 Power Supply Units, Circuit Diagram (Sheet 2 of 2)

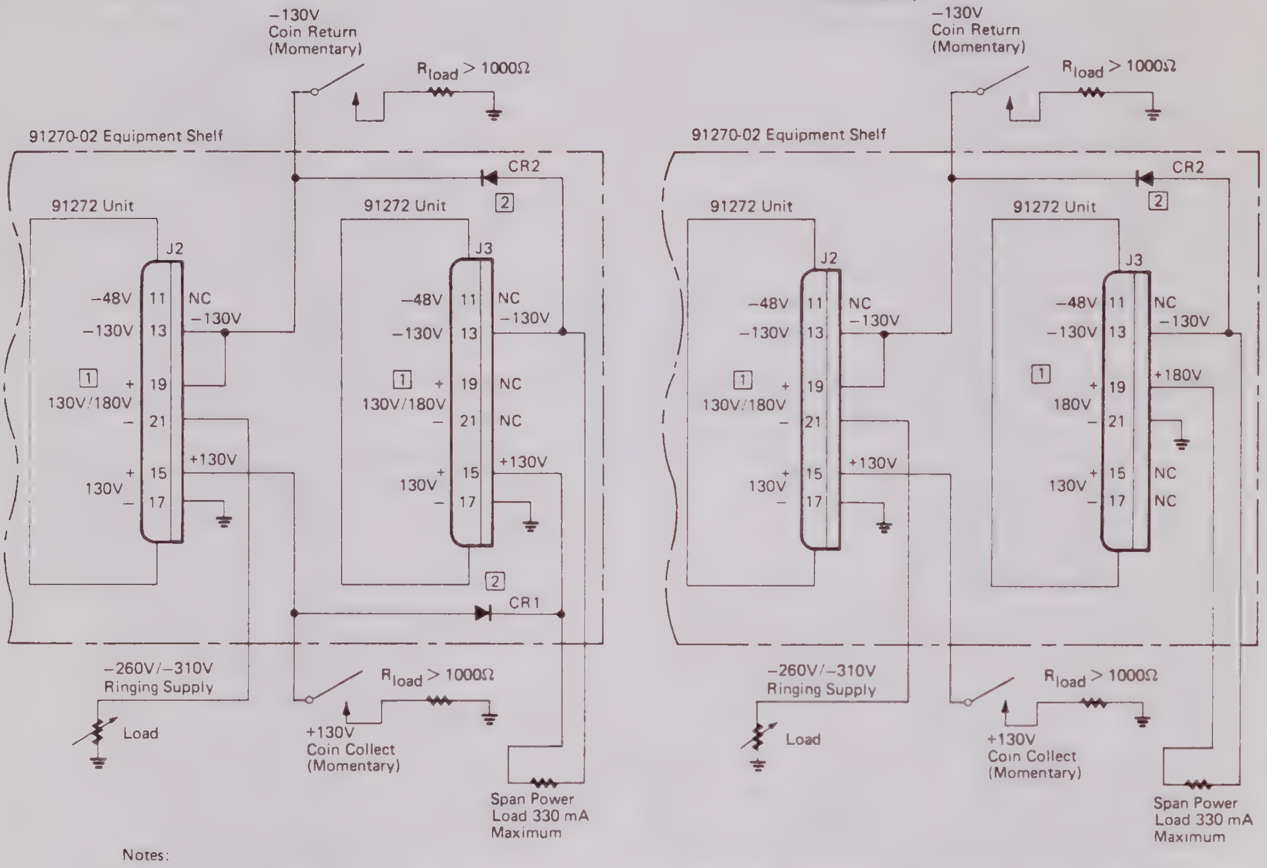


Figure C. 91272 Units in 91270-02 Shelf; Span Power at 260V (-130V and +130V)

Figure D. 91272 Units in 91270-02 Shelf; Span Power at 310V (-130V and +180V)

Notes:

1 Output Voltage Strapping Options

From	To	Voltage	Options	
213	214	Open	79V	
213	214	Strap	−130V	*
208	209	Strap	130V	*
208	207	Strap	180V	
Alarm Strapping Options for 91272-02 only				
307	308	Open	180V	
307	308	Strap	130V	*

*Factory strapping. The 130V options should be used except at a remote terminal where 180V is required for 310V span power or for ringing supply of −310V instead of −260V.

2 91270-02 Shelf. Diodes CR1 and CR2 are part of the 91270-02 shelf, used only in a remote terminal housing assembly.

3. Plugging in a 91272 Unit. If the −48V input to the 91272 unit is obtained from a 91271 unit, remove the fuse on the 91271 unit before plugging in the 91272 unit.

on the circuit diagram. The load on the ringing supply during ringing is 70 mA maximum per channel.

3.33 In the right-hand shelf mounting position (J3), an optional 91272 unit furnishes span power of up to 330 mA at +130V and −130V. Because of diodes CR1 and CR2, span current is divided between the two 91272 units but momentary coin-control or ringing overloads do not disturb the span current. When only two sets of span lines are equipped, these diodes permit span line powering without a right-hand 91272 unit.

3.34 Span power at 310V can be obtained from the 91272 unit in position J3 by utilizing the −130V output at pin 13 and the +180V output at pin 19. See figure 3-3D. For this application, the wiring of the 910A housing assembly is modified in accordance with figure 10-11.

3.35 The 91272 Power Supply Unit is available in two options. These are the 91272-01 and the 91272-02. Both provide outputs of 79, 130, and 180 Vdc. They differ in alarm functions. The 91272-01 provides a power failure alarm only on the 79-Vdc output circuit, which is generally adequate protection where a single power supply unit is used in a stand-alone (non-redundant) mode. However, lack of alarm protection on the 130 and 180-Vdc circuits would pose serious deficiencies where two power supply units are combined in a parallel redundant mode. The failure of an unprotected circuit, going undetected, could overload the remaining dc circuits. The

91272-02 is designed to prevent this condition and is the recommended unit for the redundant mode. Failure alarms are provided on all three dc output circuits. Additionally, the 91272-02 unit has a "power on" LED which indicates the status of the −48 Vdc input.

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4. FUNCTIONAL OPERATION OF CHANNEL UNITS

4.01 The channel bank can be equipped with a variety of channel units. Those used for subscriber service (including paystations) are covered in this Section. Channel units at the remote and central office ends of the system are designated as subscriber-type and office-type, respectively. Basic elements common to both types are shown in figure 4-1 and described below.

4.02 VF Transmission. At the two-wire vf port of the channel unit, there are bridging pin jack test points (2W MON) and a normalled-through miniature telephone jack (CARR 2-WIRE) that looks toward the carrier line. In a subscriber channel unit, −48V battery and ground are fed to the two-wire loop through 174 ohms; if the ring side of the loop is grounded, a thermistor resistance goes high to prevent overheating the channel unit. In an office channel unit, the two-wire drop is terminated by a 680-ohm resistor plus 42 ohms transformer winding resistance.

4.03 The incoming vf signal is coupled by a differential hybrid transformer to the transmit branch of the channel unit where an amplifier feeds it through a bandpass filter (200-3400 Hz) to the transmit gate. Amplifier gain is adjustable for lineup by the XMT LEV control. Enabled by channel pulses on the CHP-( )T lead, the transmit gate applies a sample of the instantaneous vf signal amplitude onto the transmit PAM bus every 125 µs.

4.04 In the receive branch, pulse amplitude modulated signals on the receive PAM bus are time demultiplexed by the receive gate. The gate and a 3400-Hz lowpass filter reconstruct the analog channel signal, which is amplified and fed through the hybrid transformer to the external two-wire circuit. The filter passes the voice frequency signals and the fundamental ringing frequency. The RCV LEV control has an adjustment range of about 3 dB. A compromise network balances the hybrid for a two-wire termination of 900 ohms plus 2.15 µF.

4.05 Signaling. Each vf channel includes two paths (A and B) for signaling and supervision. In the transmit direction, A and B signaling bits are gated onto separate TCS-A and TCS-B buses at the transmit channel pulse time. In the receive branch, channel signaling information on the RCS bus is gated in at the receive channel pulse time. Within the channel unit, the A and B signaling bits are time demultiplexed under the control of Sig En pulses (A and B) and Sig En B pulses.

4.06 Information transmitted in each direction on the A and B signaling paths is summarized in figure 4-2 for the various channel unit combinations of the 910A system. The logic level (1 or 0) of the A and B signaling bits on the RCS bus at the receive terminal is inverted from the logic level on the TCS-A and TCS-B buses at the distant transmit terminal. But another inversion takes place in the signaling demultiplexer so that the A and B outputs of the signaling demultiplexer have the same logic levels as shown in figure 4-2 for TCS-A and TCS-B, respectively.

Figure 4-1. Basic Channel Unit, Circuit Diagram

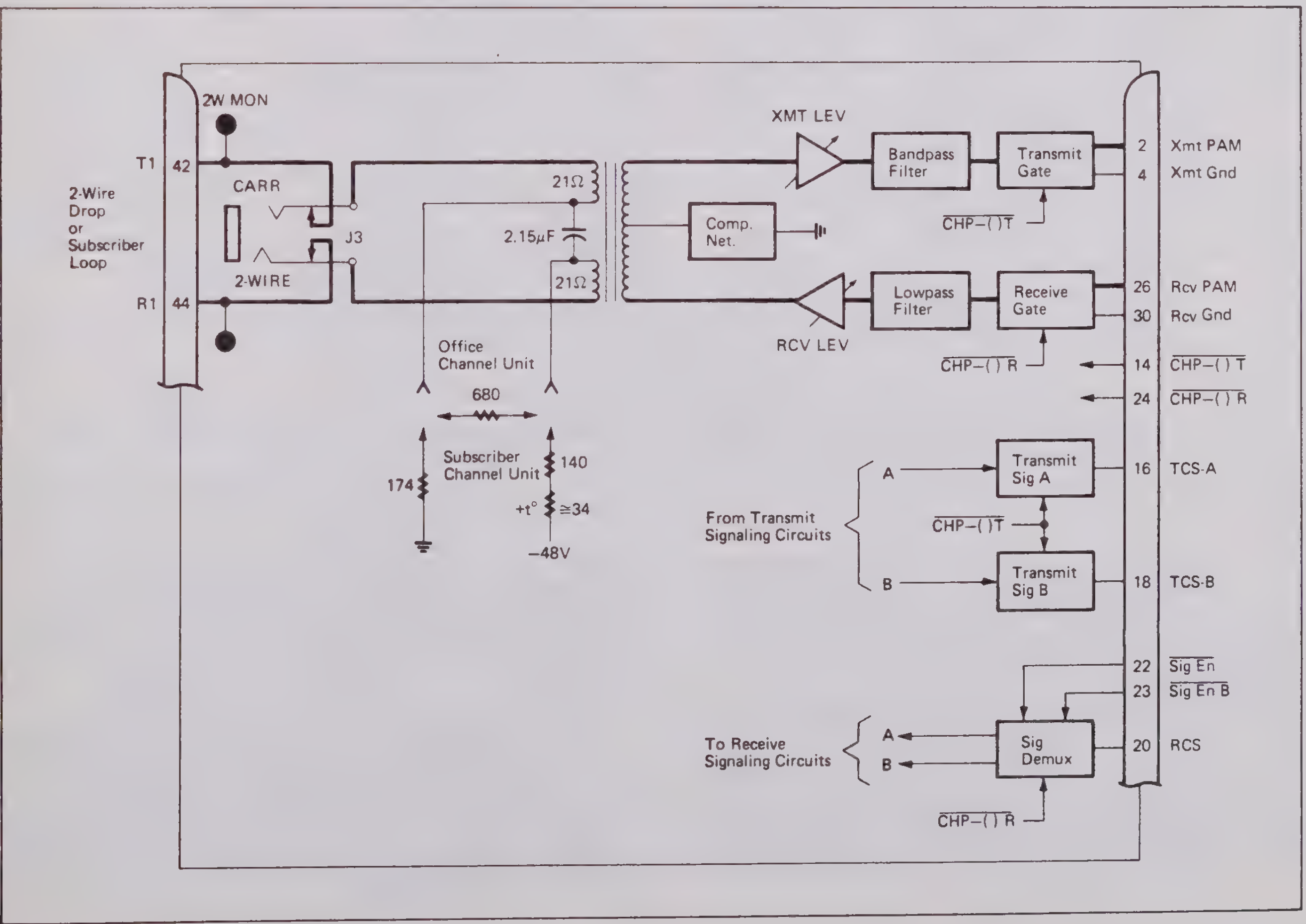

2W MON
T1
42
2-Wire
Drop
or
Subscriber
Loop
CARR
J3
2-WIRE
R1
44
21Ω
2.15µF
21Ω
Office
Channel Unit
680
Subscriber
Channel Unit
174
140
+t°
≅34
−48V
XMT LEV
Bandpass
Filter
Transmit
Gate
Comp.
Net.
CHP—( )T
Lowpass
Filter
Receive
Gate
RCV LEV
CHP—( ) R
2
Xmt PAM
4
Xmt Gnd
26
Rcv PAM
30
Rcv Gnd
14
CHP—( ) T
24
CHP—( ) R
From Transmit
Signaling Circuits
A
B
Transmit
Sig A
CHP—( )T
Transmit
Sig B
16
TCS-A
18
TCS-B
22
Sig En
23
Sig En B
To Receive
Signaling Circuits
A
B
Sig
Demux
20
RCS
CHP—( ) R

Figure 4-2. Information Transmitted on the A and B Signaling Paths

Subscriber Channel Unit	Conditions at Remote Terminal		Transmit Signaling Bus		Conditions at Central Office Terminal		S1 NORM/ TEST	Office Channel Unit
			TCS-A	TCS-B				
→ To Office								
All	Loop	Open (on-hook)	0		Released	P relay	NORM	All
		Closed (off-hook)	1		Operated			
All except 91266 FPS	Aux alarm input, pin 43	Ground		0	Open	Aux alarm output, pin 43	—	All except 91267 FPO
		Open (alarm)		1	Ground (alarm)			
91262 DRS	ANI [1]	Open		0	Released	ANI relay	—	91263 DRO
		Ground		1	Operated			
91266 FPS	Coin ground	Absent		0	Released	CG relay	—	91267 FPO
		Present		1	Operated			
To Subscriber ←								
91260 BRS	RR relay	Released	0	0	Silent	Ringing	NORM	91261 BRO
		Operated	1		Ringing			
	RR relay operated	Loop closed	0	1	Bat. or open	XMT SIG pin jack	TEST	
		Loop open	1		Ground			
91262 DRS	RR and RT relays	Both released	0	0	Silent	Ringing	NORM	91263 DRO
		RR operated	1 [2]	0	Ring to ground			
		RT operated		1	Tip to ground			
	RR and RT operated	Loop closed	0	1 [2]	Bat. or open	XMT SIG pin jack	TEST	
		Loop open	1		Ground			
91264 SRS	RR, RT and PL relays	All released	0	0	Silent	Ringing	NORM	91265 SRO
		RR operated	1	0	Ring negative			
		RT operated		B3=1	Tip negative			
		RR & PL operated		B1=1	Ring positive			
		RT & PL operated		B1=1, B3=1	Tip positive			
	RR and RT operated	Loop closed	0	B4=1	Bat. or open	XMT SIG pin jack	TEST	
		Loop open	1		Ground			
91266 FPS	RR relay	Released	0	0	Silent	Ringing	NORM	91267 FPO
		Operated		B1=1	Ringing			
	CS relay operated		1	0	Coin check (—48V on tip)			
	CF relay released	CS operated	0	B2=1	Coin collect (+90V to +135V on tip)			
		CS released	0	B4=1	Coin return (—90V to —135V on tip)			
	PV relay operated (Code A)		1	B6=1	TCMF disable [3]			
	RR operated & CF released	Loop closed	0	B3=1	Bat. or open	XMT SIG pin jack	TEST	
		Loop open	1		Ground			
91268 SPS	On-hook & F relay rls	RR released	0	0	Silent	Ringing	NORM	91269 SPO
		RR operated	1		Ringing			
	Off-hook & RR relay rls	F released	0	0	Normal bat.	Answer supervision		
		F operated	1		Reverse bat.			
	RR relay operated	Loop closed	0	1	Bat. or open	XMT SIG pin jack	TEST	
		Loop open	1		Ground			

Notes:

[1] In the 91262 DRS to 91263 DRO direction, ANI information is transmitted for 26 milliseconds after a loop transition.

[2] In the 91263 DRO to 91262 DRS direction with TCS-A and TCS-B both at logic 0, logic 1 first on TCS-A establishes the ringing mode and logic 1 first on TCS-B establishes the loopback test mode.

[3] TCMF disable command is +48V on the tip lead and ground on the ring lead. The 91267 FPO will also respond to reverse battery.

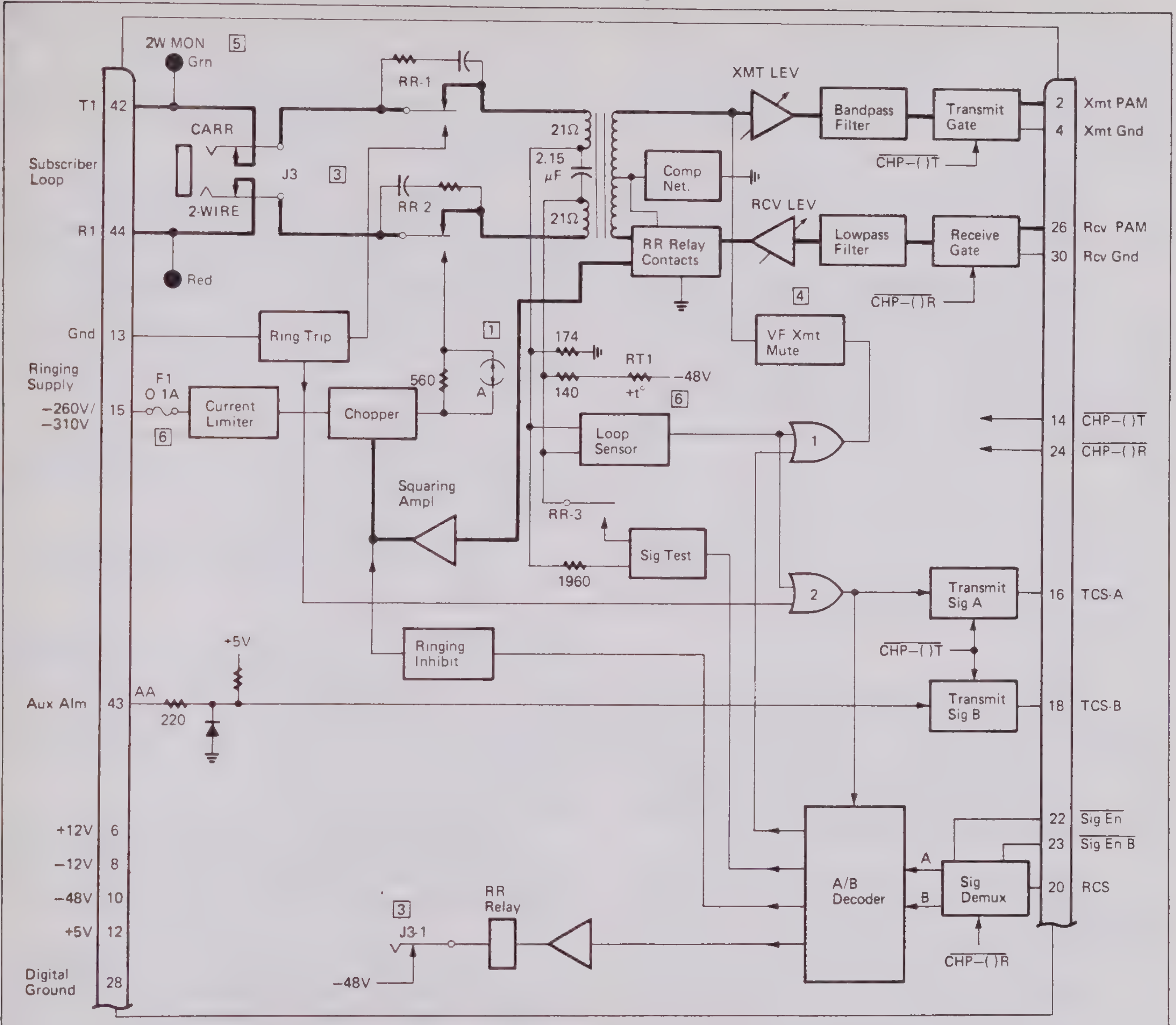
4.07 With two of the channel unit combinations, 91265 to 91264 and 91267 to 91266, signaling bits and synchronization bits are submultiplexed on the B path over a multiframe period. Signaling bits are designated B1, B2, B3, etc. in the sequence in which they are transmitted.

91260 Bridged Ringing Subscriber Channel Unit

4.08 The 91260 channel unit (figure 4-3) provides subscriber line service with four-party frequency-selective bridged ringing and ONI (operator number identification). The remote 91260 channel unit works with the 91261 Bridged Ringing Office Channel Unit at the central office terminal. The description below of the 91260 channel unit is also applicable as background for the descriptions in this Part of other subscriber-type channel units. Basic elements common to all channel units were covered previously at the beginning of this Part.

4.09 VF Transmission. The subscriber loop passes through normally-closed contacts of the RR (ringing) relay to the hybrid transformer. With the subscriber on-hook, the vf transmit branch of the channel unit is muted to prevent singing. Through gate 1, the mute is removed by an off-hook signal from the loop sensor or by a loopback test mode indication from the A/B decoder.

Figure 4-3. 91260 Bridged Ringing Subscriber Channel Unit, Circuit Diagram


2W MON 5
Grn
T1 42
Subscriber Loop
R1 44
CARR
2-WIRE
J3 3
Red
RR-1
RR 2
21Ω
2.15 μF
21Ω
XMT LEV
Bandpass Filter
Transmit Gate
CHP—( )T
Comp Net.
RCV LEV
RR Relay Contacts
Lowpass Filter
Receive Gate
CHP—( )R
4
VF Xmt Mute
2 Xmt PAM
4 Xmt Gnd
26 Rcv PAM
30 Rcv Gnd
Gnd 13
Ring Trip
1
174
RT1
−48V
140
+t°
6
Ringing Supply
F1
0 1A
−260V/ −310V 15
6
Current Limiter
Chopper
560
A
Loop Sensor
1
14 CHP—( )T
24 CHP—( )R
Squaring Ampl
RR-3
Sig Test
1960
2
Transmit Sig A
16 TCS-A
CHP—( )T
Ringing Inhibit
+5V
Aux Alm 43
AA
220
Transmit Sig B
18 TCS-B
+12V 6
−12V 8
−48V 10
+5V 12
Digital Ground 28
3
J3-1
RR Relay
−48V
A/B Decoder
A
B
Sig Demux
22 Sig En
23 Sig En B
20 RCS
CHP—( )R

Notes:

1 Cross-Ringing. At the factory, the 560-ohm resistor at the chopper output is bypassed by tightening screw-strap A. Loosen screw-strap A for short loops to alleviate cross-ringing, if present.

Prior to Issue 6 of model 2, a mobile wire-strap was used instead of a screw-strap. Strap A-B to bypass the resistor or strap B-C to remove the bypass.

2 High-Voltage Warning. High ringing voltage can be encountered on exposed printed circuits. Avoid contact with printed circuits when installing or removing channel unit and for several seconds after removal.

3 Telephone Jack J3. Was not on 91260 model 1.

4 VF Transmit Mute. Was not on 91260 model 1 prior to Issue 5.

5 2W MON Test Points. Tip/ring colors were red/green on 91260 model 1.

6 Fuse F1 and Thermistor RT1. Were not on 91260 model 2 prior to Issue 5. Fuse F1 was 0.1A prior to Issue 11.

4.10 Transmit Signaling. On-hook and off-hook signals (and dial pulses) are transmitted on the A signaling path. An off-hook state on the subscriber loop is detected by the loop sensor or, during ringing, by the ring trip circuit. Through gate 2 and the transmit signaling A circuit, TCS-A stays at logic 1 (off-hook) or is forced to logic 0 (on-hook) at transmit channel pulse time. The B signaling path is assigned to transmitting an auxiliary alarm indication to the central office. Ground (normal condition) on the alarm input lead forces the TCS-B bus to 0 at transmit channel pulse time.

4.11 Receive Signaling. Through the A/B decoder, the A and B signaling bits control ringing and remote-looped testing. Normal and loopback test commands are received on the B signaling path according to the position of the NORM/TEST switch on the associated channel unit at the central office. In the normal mode, the two logic states of the A signaling path represent the silent and ringing conditions. In the loopback test mode, they represent off-hook (loop closed) and on-hook (loop open).

4.12 Ringing. In the normal (non-test) mode, operation of the RR relay diverts sine-wave ringing signals from the vf receive branch through a squaring amplifier to drive a chopper. At the ringing frequency, the chopper closes the ring side of the subscriber loop to the optional −260V or −310V ringing supply voltage. Current is limited to about 70 mA. To minimize cross-ringing on short loops, the ringing voltage can be reduced by strapping B-C instead of A-B as shown in figure 4-3.

4.13 Through logic circuits in the A/B decoder, ringing is inhibited by the subscriber going off-hook (gate 2) or by a loopback test command received on the B signaling path.

4.14 Remote-Looped Testing. The RR relay is operated in the loopback test mode also, but ringing is inhibited as mentioned in the preceding paragraph. Contacts RR-1 and RR-2 open the two-wire side of the hybrid transformer; other contacts of the RR relay short the compromise network and insert loss in the receive branch. In this configuration, the transformer couples the received vf signal into the transmit branch at the proper level for retransmission to the central office.

4.15 Through contacts RR-3, the loop sensor is connected to the output of the signaling test circuit, which closes the loop with a 1960-ohm resistor in response to an off-hook condition received on the A signaling path. The loop closure is detected and an off-hook condition is retransmitted. In the same way, test dial pulses are returned to the central office where they can be checked for distortion.

4.16 Local Testing. Channel receive level may be checked locally by using the 91232 Test and Alignment Set to inject a 1-kHz test tone digitally in the receive branch of the common equipment. However, because the digital pattern of the test tone includes time slots of the A and B signaling bits, the RR relay may operate and open the loop. To prevent this, the relay is disabled by opening of contacts J3-1 when a test cord is plugged into CARR 2-WIRE jack J3.

4.17 Removal of Subscriber Channel Unit. Unplugging the subscriber channel unit leaves TCS-A and TCS-B at logic 1, received by the office channel unit as off-hook and auxiliary alarm indications, respectively.

91262 Divided Ringing Subscriber Channel Unit

4.18 The 91262 channel unit (figure 4-4) is very much like the 91260 channel unit, but with the signaling function expanded to include ANI in the transmit direction and ringing party identification (tip or ring) in the receive direction. The remote 91262 channel unit works with the 91263 Divided Ringing Office Channel Unit at the central office terminal. Differences from the 91260 channel unit (paragraph 4.08) are covered below.

4.19 Transmit Signaling. Ordinarily, the B signaling path carries auxiliary alarm information, but at each change in the output of the loop sensor (a loop transition), the signaling B submultiplexer switches to ANI information for about 26 milliseconds. The ANI detector responds to tip-party ground applied at the subscriber telephone set through an inductor or ringer center tap or through a resistor mark on the dial. It will not work with a type A SATT spotter dial.

4.20 Timing signals used in the signaling B submultiplexer are derived from the frame sync pulses occurring every 1500 μs at frame 6 time.

4.21 Receive Signaling. In the normal mode, the two logic states of the A signaling path represent silent and ringing conditions and the two logic states of the B path represent ringing party identification, ring or tip. If the channel is idle, both the A and B outputs of the signaling demultiplexer are logic 0. If A goes to logic 1 first, the A/B decoder latches into a ringing mode so that, 0 on B will operate the RR relay (ring) or on B the RT relay (tip). From the idle channel state, if B goes to logic 1 first, the A/B decoder latches into the test mode. Before the decoder can change from one mode to the other, A and B must both return to logic 0.

4.22 Ringing. If the RR relay operates, negative ringing voltage is connected to the ring side of the subscriber loop and positive ground to the tip side; if the RT relay operates, the connections are reversed. At the output of the receive amplifier, when either RR or RT operates, ringing signals from the vf receive branch are diverted to drive a chopper. Ground through another contact of RR or RT alters the operating characteristics of the receive amplifier so that it squares the incoming sine-wave ringing signal. (A separate squaring amplifier is not used.)

4.23 Remote-Looped Testing. In the loopback test mode, both RR and RT relays operate, configuring the channel unit for remote-looped testing in the manner described for the 91260 channel unit.

91264 Superimposed Ringing Subscriber Channel Unit

4.24 The 91264 channel unit (figure 4-5) provides four-party full-selective ringing or eight-party semi-selective ringing. Ringing voltage polarity, tip/ring party selection, and ringing frequency are detected by the 91265 SRO channel unit at the central office and reproduced by the 91264 SRS channel unit. Differences from the 91260 channel unit (paragraph 4.08) are covered below.

4.25 Receive Signaling. In the A/B decoder, a subframe of eight consecutive B signaling bits is time demultiplexed. Four bits are used to synchronize the subframe and four bits are assigned as follows: B1, ringing polarity; B2, unassigned; B3, tip/ring ringing; B4, loopback test command.

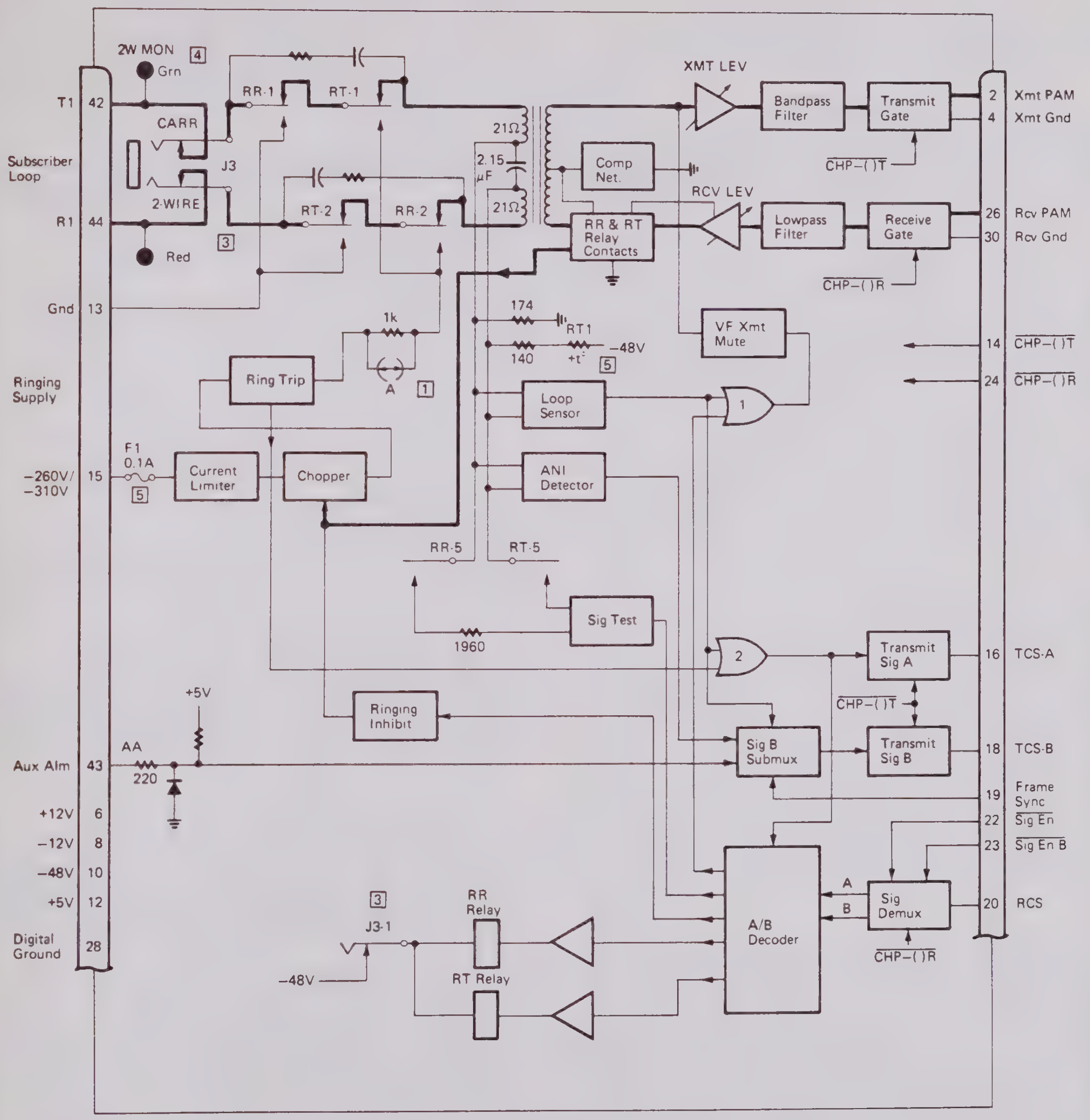
4.26 Normal and loopback test commands are received on the B4 signaling bit according to the position of the NORM/TEST switch on the 91265 Superimposed Ringing Office Channel Unit at the central office terminal. In the normal mode the two logic states of the A signaling bit represent silent and ringing. In the test mode, they represent off-hook (loop closed) and on-hook (loop open).

4.27 Ringing. When the A output of the signaling demultiplexer goes to logic 1 as a ringing command, the RR relay operates if B is logic 0, or the RT relay operates if B3 is 1. If B1 is logic 1, the PL (polarity) relay also operates. With the PL relay released, an operated RR relay connects negative polarity ringing voltage to the ring side of the subscriber loop and ground to the tip side; an operated RT relay makes opposite connections.

4.28 At the output of the receive amplifier, when either RR or RT operates, ringing signals from the vf receive branch are diverted to drive a chopper. Ground through another contact of RR or RT alters the operating characteristics of the receive amplifier so that it squares the incoming sine-wave signal. (A separate squaring amplifier is not used.)

4.29 With the PL relay released, the ringing square-wave swings from −260V or −310V to ground, equivalent to 130 or 155 volts rms. Because the waveform remains

Figure 4-4. 91262 Divided Ringing Subscriber Channel Unit, Circuit Diagram


2W MON
4
Grn
T1
42
CARR
Subscriber Loop
J3
2-WIRE
R1
44
3
Red
RR-1
RT-1
RT-2
RR-2
21Ω
2.15 μF
21Ω
Comp Net.
RR & RT Relay Contacts
XMT LEV
Bandpass Filter
Transmit Gate
CHP–( )T
RCV LEV
Lowpass Filter
Receive Gate
CHP–( )R
2
Xmt PAM
4
Xmt Gnd
26
Rcv PAM
30
Rcv Gnd
Gnd
13
174
RT1
140
+t°
5
–48V
1k
A
1
Ring Trip
VF Xmt Mute
14
CHP–( )T
24
CHP–( )R
Ringing Supply
Loop Sensor
1
F1
0.1A
5
–260V/
–310V
15
Current Limiter
Chopper
ANI Detector
RR-5
RT-5
Sig Test
1960
2
Transmit Sig A
16
TCS-A
CHP–( )T
+5V
Ringing Inhibit
AA
220
Aux Alm
43
Sig B Submux
Transmit Sig B
18
TCS-B
19
Frame Sync
+12V
6
22
Sig En
–12V
8
23
Sig En B
–48V
10
A
B
Sig Demux
20
RCS
+5V
12
3
J3-1
RR Relay
A/B Decoder
CHP–( )R
Digital Ground
28
–48V
RT Relay

Notes:

1 Cross-Ringing. At the factory, the 1000-ohm resistor at the ring-trip output is bypassed by tightening screw-strap A. Loosen screw-strap A for short loops to alleviate cross-ringing, if present.

Prior to Issue 5 of model 2, a mobile wire-strap was used instead of a screw-strap. Strap A-B to bypass the resistor or strap B-C to remove the bypass.

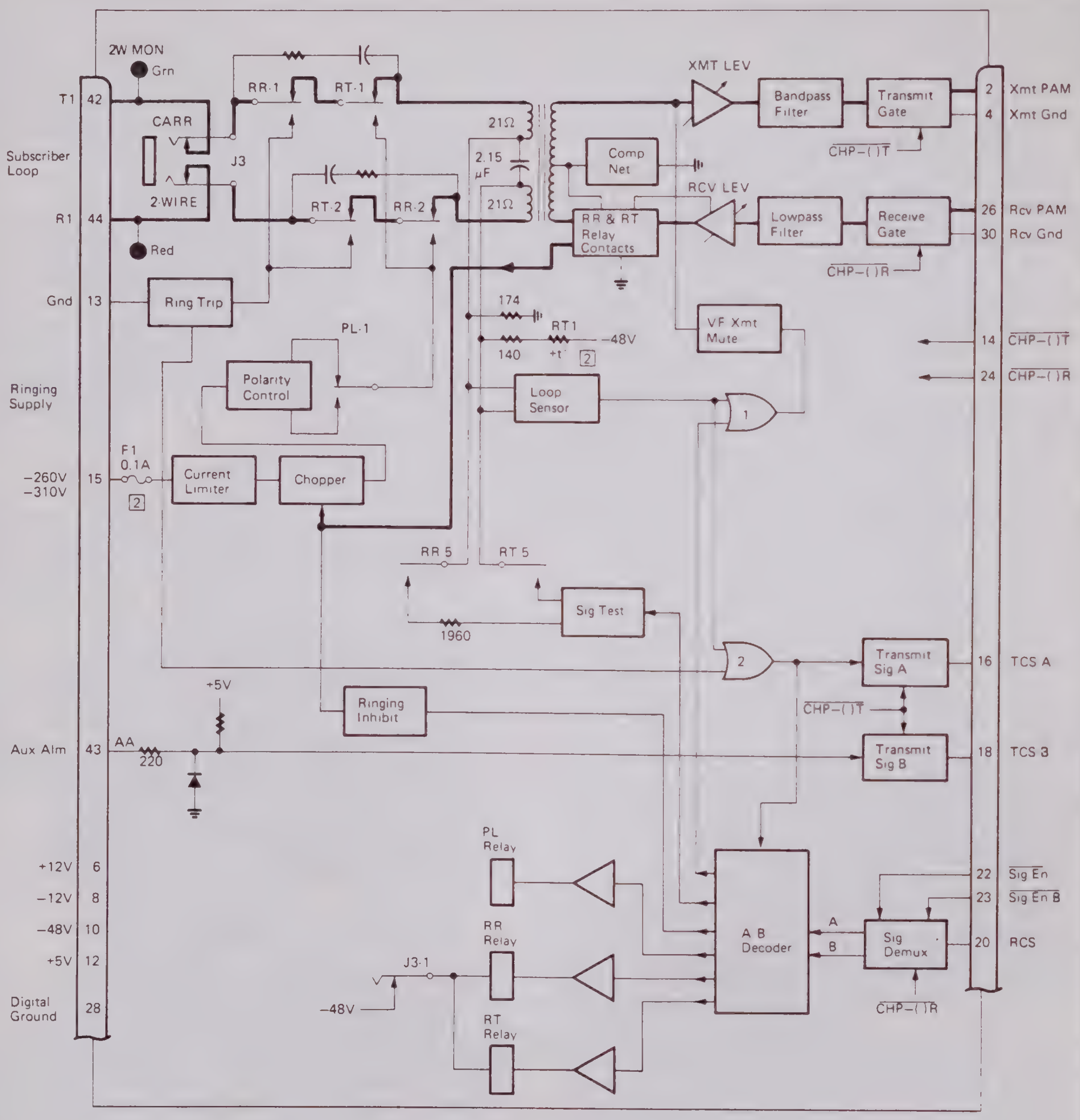
2 High-Voltage Warning. High ringing voltage can be encountered on exposed printed circuits. Avoid contact with printed circuits when installing or removing channel unit and for several seconds after removal.

3 Telephone Jack J3. Was not on 91262 model 1.

4 2W MON Test Points. Tip/ring colors were red/green on 91262, model 1.

5 Fuse F1 was not on 91262 Model 2 prior to Issue 4 and was 0.1A prior to Issue 11.

Figure 4-5. 91264 Superimposed Ringing Subscriber Channel Unit, Circuit Diagram


2W MON
Grn
T1
42
Subscriber Loop
CARR
J3
2-WIRE
R1
44
Red
RR-1
RT-1
RT-2
RR-2
21Ω
2.15 µF
21Ω
Comp Net
RR & RT Relay Contacts
XMT LEV
RCV LEV
Bandpass Filter
Transmit Gate
CHP—( )T
Lowpass Filter
Receive Gate
CHP—( )R
2
Xmt PAM
4
Xmt Gnd
26
Rcv PAM
30
Rcv Gnd
Gnd
13
Ring Trip
PL-1
174
RT1
+t°
140
−48V
2
VF Xmt Mute
14
CHP—( )T
24
CHP—( )R
Ringing Supply
Polarity Control
Loop Sensor
1
F1
0.1A
−260V
−310V
15
2
Current Limiter
Chopper
RR 5
RT 5
Sig Test
1960
2
Transmit Sig A
16
TCS A
CHP—( )T
+5V
Ringing Inhibit
Aux Alm
43
AA
220
Transmit Sig B
18
TCS B
PL Relay
+12V
6
−12V
8
−48V
10
+5V
12
Digital Ground
28
RR Relay
J3-1
−48V
RT Relay
A B Decoder
A
B
Sig Demux
CHP—( )R
22
Sig En
23
Sig En B
20
RCS

Notes:

1 High-Voltage Warning. High ringing voltage can be encountered on exposed printed circuits. Avoid contact with printed circuits when installing or removing channel unit and for several seconds after removal.

2 Fuse F1 and Thermistor RT1. Were not on 91264 prior to Issue 7. Fuse F1 was 0.1A prior to Issue 11.

negative, positive ringers are not activated. With the PL relay operated, the polarity control circuit inverts the ringing squarewave so that it swings from ground to about +260V or +310V; now, negative ringers are not activated. This full polarity reversal is superior to conventional superimposed ringing techniques that need separate dc bias and ringing voltages with amplitudes closely controlled to prevent cross-ringing.

4.30 Remote-Looped Testing. When a loopback test command is received (B4 at logic 1), both RR and RT relays operate, configuring the channel unit for remote-looped testing in the manner described for the 91260 channel unit.

91266 Full-Prepay Subscriber Channel Unit

4.31 The 91266 channel unit (figure 4-6) provides paystation line service with bridged ringing and ± 130V coin control. The channel unit is compatible with single-slot or multislot coin stations equipped with a rotary dial or TCMF (touch-call multifrequency) pad. One extension ringer or no-dial extension telephone can be used also.

4.32 Applications of the two optional channel unit configurations are described in figure 6-1. Code A of the 91266 channel unitis an optional plug-in subassembly that permits the central office to disable the TCMF pad by application of +48V to the ring side of the two-wire drop. This is done to prevent the party from fraudulently using the TCMF pad to simulate tones that identify deposited coins to the operator. The -01, -03, and Code A plug-in subassemblies are field replaceable where a configuration change is required.

4.33 To install Code A on the 91266 Full-Prepay Subscriber Channel Unit, refer to figure 4-7 while performing the following steps:

(a) Remove the through-strap plug assembly 087-56146-01 from J4 on the 91266 unit. This assembly will no longer be used.

(b) Using two screws and two mica washers, install code A assembly 087-55378-01 on the 91266 circuit board.

(c) Connect P4 (multi-pin plug on code A assembly) to J4 on 91266 circuit board.

(d) Connect P5 (single-pin plug on code A) to J5 on 91266 circuit board.

4.34 The remote 91266 Full-Prepay Subscriber Channel Unit works with the 91267 Full-Prepay Office Channel Unit at the central office terminal. Differences from the 91260 channel unit (paragraph 4.08) are described in the following paragraphs.

4.35 VF Transmission. On the 91266-01 channel unit, the subscriber loop passes through normally-closed contacts of the RR, CF (coin-function), and CS (coin sensing) relays. On the 91266-03 channel unit, the CS relay is operated in the idle channel condition. Contacts CS-1 remove ground from the tip side of the loop, but strap C-D is installed to close −48V to the ring side. Bridging two-wire test points are provided but the usual normalled-through telephone jack is not.

4.36 Transmit Signaling. Instead of auxiliary alarms, the B signaling path is assigned to transmission of information about the presence of coins in the paystation coin relay hopper. From the coin detection subassembly at J3-5, coin absent and coin present are logic 1 and 0, respectively. At TCS-B, the corresponding logic levels are 0 and 1.

4.37 Receive Signaling. In the A/B decoder, a subframe of 10 consecutive B signaling bits is time demultiplexed. Four bits are used to synchronize the subframe and six bits are assigned to the following commands from the central office equipment: B1, ringing; B2, coin collect; B3, loopback; B4, coin return; B5, unassigned; B6, TCMF disable (used with Code A only).

4.38 Normal and loopback commands are received on the B3 signaling bit according to the position of the NORM/TEST switch on the 91267 channel unit at the central office terminal. In the normal mode (B3 at 0), logic 1 at the A output of the signaling demultiplexer is a coin check command. In the loopback test mode (B3 at 1), logic 0 and 1 represent off-hook and on-hook, respectively.

4.39 Ringing. In the normal (non-test) mode, operation of the RR relay diverts sine-wave ringing signals from the vf receive branch through an amplifier driving the RC (ringing chopper) relay. Other contacts of RR and CF alter the operating characteristics of the receive amplifier so that it squares the incoming sine-wave signal. Contacts RC-1 switch the ring side of the loop between ground and −260V or −310V at the frequency received on the vf path, generating a unipolar square-wave that actuates the paystation ringer.

4.40 On a terminating call, off-hook is detected by the 91266-01 unit during either the silent or ringing interval. However, as explained later, the 91266-03 unit depends on the ring trip circuit to detect off-hook.

4.41 Remote-Looped Testing. When a loopback command is received (B3 at 1), the RR relay operates and the CF relay releases, configuring the channel unit for remote-looped testing in the manner described for the 91260 channel unit. In the A/B decoder, the A signaling bits are directed to the signaling test circuit instead of to the CS relay.

4.42 Coin Collect. A coin collect command (B2 at 1) operates the CS relay and releases the CF relay. From contacts CS-3, +130V goes through the coin detection subassembly (in at J3-10 and out at J3-6) to the tip side of the subscriber loop. As an option, with A-B strapped, +130V is applied to both tip and ring. The +130V on the loop causes the paystation coin relay to collect the coin. The −130V at contacts CS-3 does not reach the loop because CS operates before CF releases, and vice versa.

4.43 Coin Return. A coin return command (B4 at 1) releases the CF relay but does not operate the CS relay. From contacts CS-3, −130V is applied to the subscriber loop as described in the preceding paragraph, causing the paystation coin relay to return the coin.

▶4.44 Coin Detection Subassembly For 91266-01. This channel unit is used for coin-first operation or coin-free emergency, directory, and operator type service with offices so designed or modified. The unit is for use with GTE Automatic Electric offices and Stromberg-Carlson XY offices. A GTE Automatic Electric No. 1 EAX office must be equipped with FB-10156-1 coin office junctors. Refer to figure 4-6A. The ◀ inputs to the tip-ground detector (J3-14 and -4) are bridged across the subscriber loop. When a coin is deposited, the paystation connects a 1000-ohm resistance from the tip side of the loop to ground. The longitudinal unbalance is detected and the logic level at J3-5 is switched from 1 to 0. This coin present indication is returned to the central office on the B signaling path. As described later, the TCMF disable subassembly (Code A) may apply ground to J3-12 to inhibit a false coin present indication.

4.45 The CP (coin present) relay and its protection network are in series with the coin voltage (+130V or −130V) applied to the loop to collect or return a coin at the paystation. For the application of coin voltage, the CF relay releases, opening the loop and disabling the tip-ground detector. However, if a coin is present, the CP relay operates, closing logic 0 to P3-5. Upon a second application of coin voltage, if the coin has been collected or returned, CP does not operate and coin present is not indicated. If the coin is still present, CP operates and the central office again tries to collect or return the coin.

4.46 Coin Detection Subassembly For 91266-03. This channel unit is used primarily for coin-first operation on Western Electric paystations that have the tip side of the subscriber loop open when idle. (Tip must be open for correct operation of the totalizer.) The CF and CS relays are normally operated and C-D is strapped. See figure 4-6B for the subassembly circuit diagram.

4.47 In the idle channel condition, the inputs to the subassembly from the loop sensor at J3-3 and from the CF relay control at J3-9 are both logic 0, making the U25A output logic 1 at J3-13. Through a flip-flop in the A/B decoder, the CS relay is operated. With contacts CS-1 operated and C-D

(Text continues on page 22.)

Figure 4-6. 91266 Full-Prepay Subscriber Channel Unit, Circuit Diagram (Sheet 1 of 2)

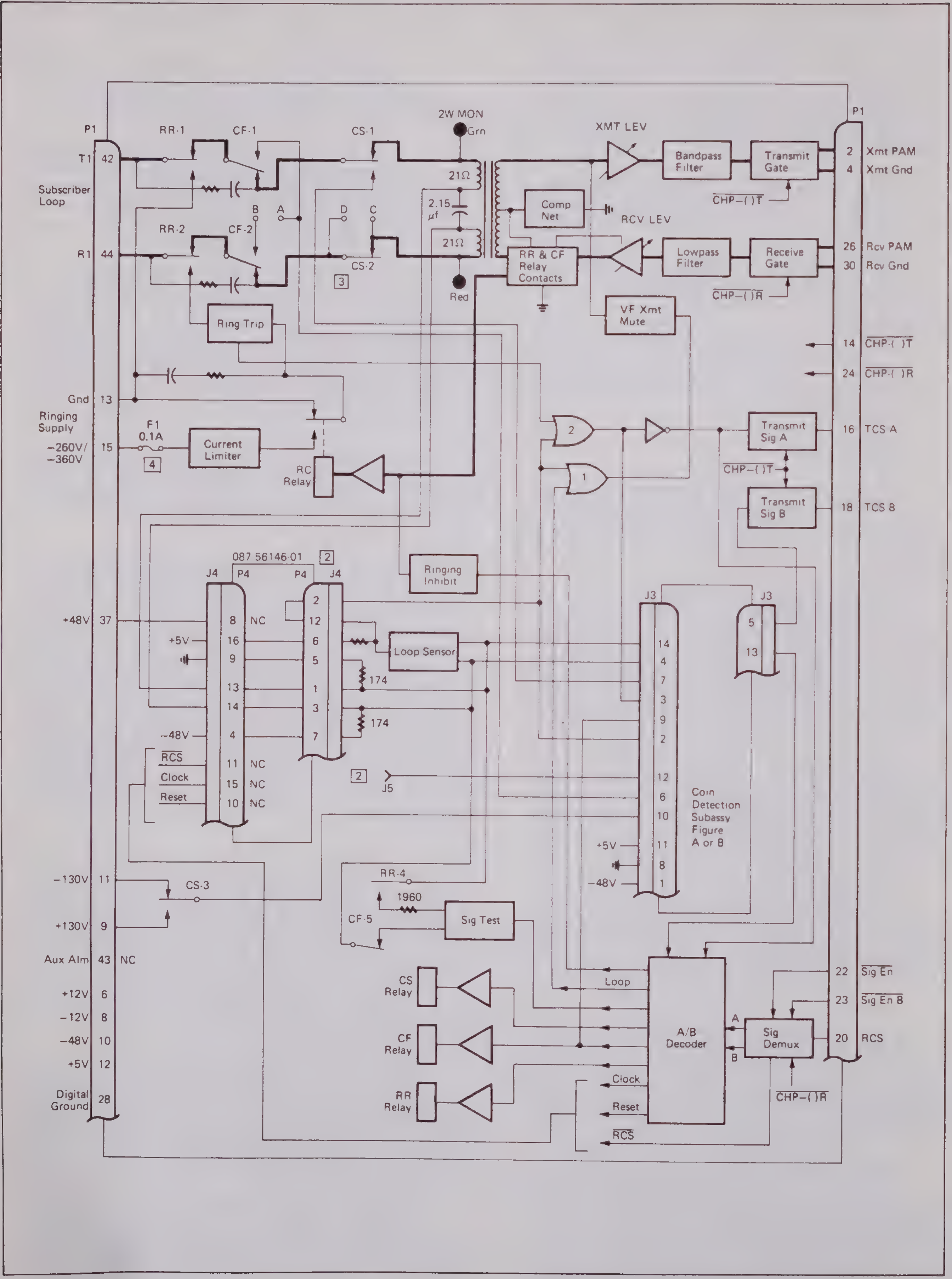

P1
T1 42
Subscriber Loop
R1 44
RR-1
CF-1
CS-1
2W MON
Grn
XMT LEV
Bandpass Filter
Transmit Gate
P1
2 Xmt PAM
4 Xmt Gnd
B
A
D
C
21Ω
2.15 μf
21Ω
Red
Comp Net
RCV LEV
CHP–( )T
RR-2
CF-2
CS-2
3
RR & CF Relay Contacts
Lowpass Filter
Receive Gate
26 Rcv PAM
30 Rcv Gnd
CHP–( )R
Ring Trip
VF Xmt Mute
14 CHP-( )T
24 CHP-( )R
Gnd 13
Ringing Supply
F1 0.1A
–260V/ –360V 15
4
Current Limiter
RC Relay
2
1
Transmit Sig A
16 TCS A
CHP–( )T
Transmit Sig B
18 TCS B
087 56146-01
2
J4
P4
P4
J4
Ringing Inhibit
J3
J3
+48V 37
8 NC
2
12
+5V
16
6
9
5
Loop Sensor
174
13
1
14
3
174
–48V
4
7
RCS
Clock
Reset
11 NC
15 NC
10 NC
2
J5
5
13
14
4
7
3
9
2
12
6
10
11
8
1
+5V
–48V
Coin Detection Subassy Figure A or B
–130V 11
CS-3
+130V 9
RR-4
1960
CF-5
Sig Test
Aux Alm 43 NC
+12V 6
–12V 8
–48V 10
+5V 12
Digital Ground 28
CS Relay
CF Relay
RR Relay
Loop
A/B Decoder
Clock
Reset
RCS
A
B
Sig Demux
22 Sig En
23 Sig En B
20 RCS
CHP–( )R

Figure 4-6. 91266 Full-Prepay Subscriber Channel Unit, Circuit Diagram (Sheet 2 of 2)

Figure A. Balanced Coin Subassembly, Part of 91266-01

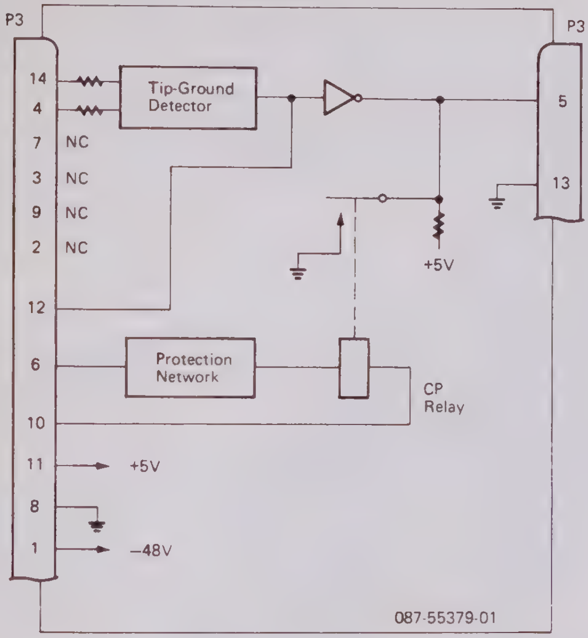

P3
14
4
7 NC
3 NC
9 NC
2 NC
12
6
10
11 +5V
8
1 −48V
Tip-Ground Detector
Protection Network
CP Relay
+5V
P3
5
13
087-55379-01

Figure B. Coin First/Tip Open Subassembly, Part of 91266-03.

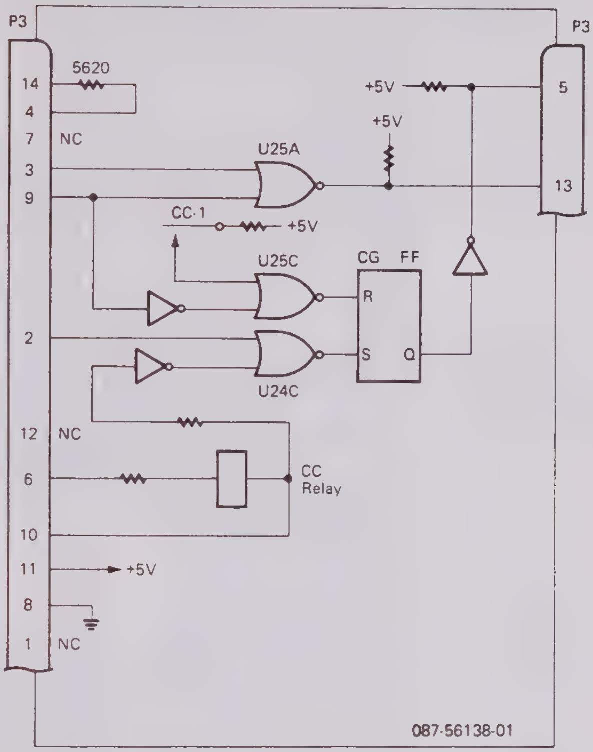
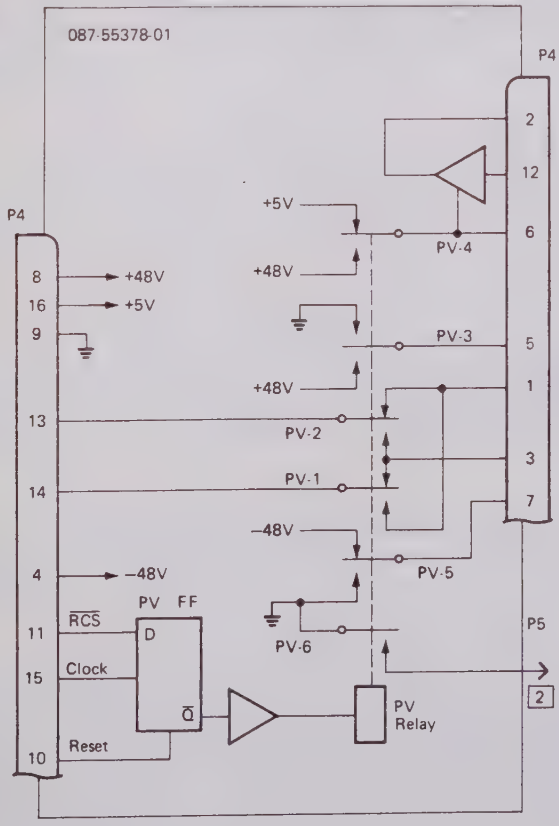

P3
5620
14
4
7 NC
3
9
2
12 NC
6
10
11 +5V
8
1 NC
U25A
CC-1
+5V
U25C
U24C
CG FF
R
S Q
CC Relay
+5V
+5V
P3
5
13
087-56138-01

Figure C. TCMF Disable Subassembly, Code A of 91266-01, or -03.


087-55378-01
P4
8 +48V
16 +5V
9
13
14
4 −48V
11
15
10
RCS
Clock
Reset
PV FF
D
Q̄
+5V
+48V
+48V
−48V
PV-4
PV-3
PV-2
PV-1
PV-5
PV-6
PV Relay
P4
2
12
6
5
1
3
7
P5
2

Notes:

1. High-Voltage Warning. High ringing voltage can be encountered on exposed printed circuits. Avoid contact with printed circuits when installing or removing channel unit and for several seconds after removal.

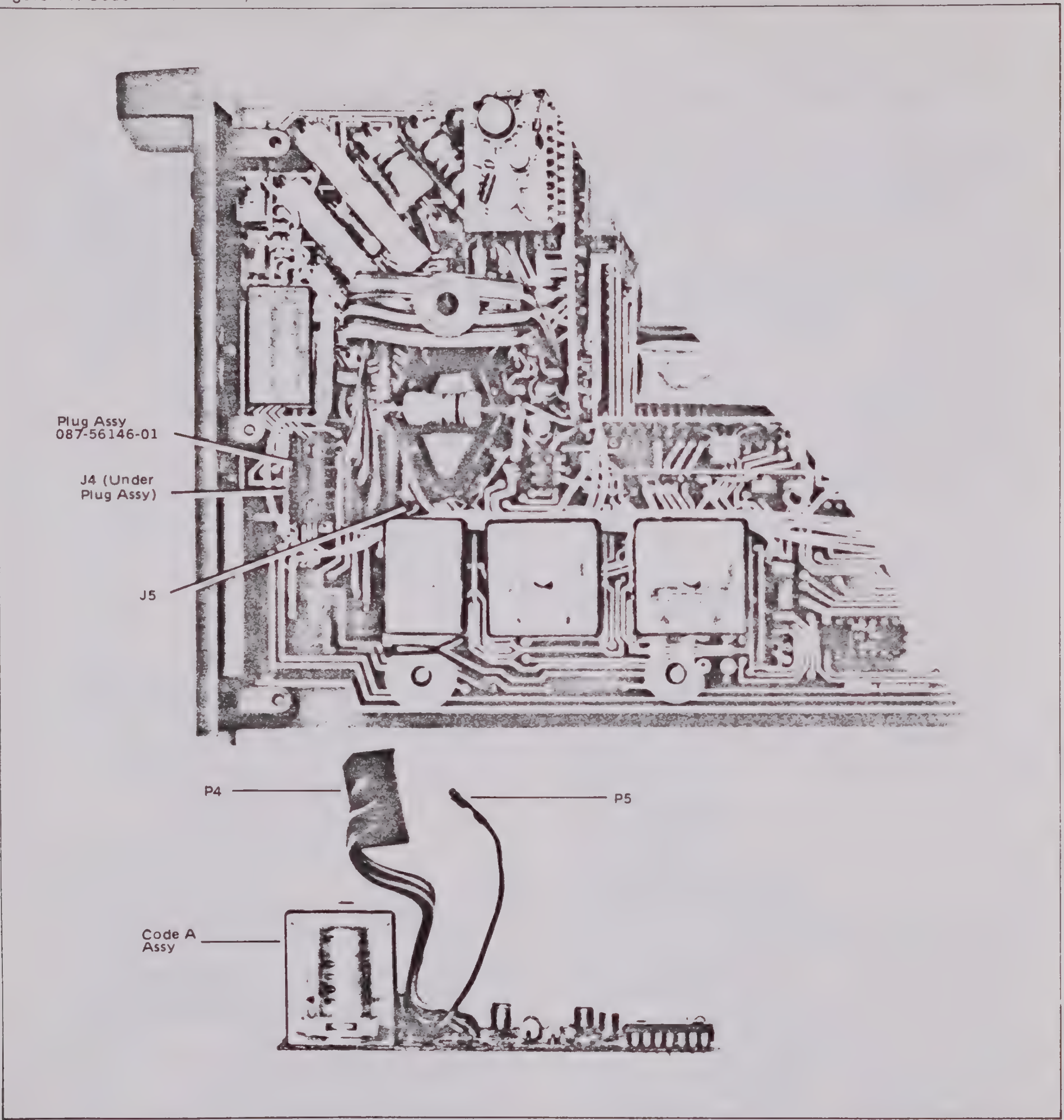
2. Code A. To equip the channel unit with Code A, replace Through-Strap Plug Assembly 087-56146-01 with TCMF Disable Subassembly 087-55378-01 (Figure C). Insert single-conductor plug P5 in receptacle J5 on the printed circuit board. See fig. 4-7 and Para. 4.33.

3. Channel Unit Strapping. Strap the 91266 channel unit for the applicable options listed below.

Option		Strap
Coin voltage	Tip only	
	Tip and ring	A-B
91266-03 channel unit		C-D

4. Fuse F1. Was not on 91266 Issue 1.

Figure 4-7. Code A Installation, 91266 Unit



(Continued from page 19.)

strapped, the tip side of the subscriber loop is open and the ring side is closed to normal −48V battery feed.

4.48 When a coin is deposited, the paystation connects a 1000-ohm resistance to the tip side of the loop. Through the hookswitch, this coin ground also appears on the ring side and is detected by the loop sensor. Gate 2 applies logic 1 to J3-3, J3-13 goes to logic 0, and the CS relay is deenergized. Before the CS relay actually releases, logic 0 at J3-2 from the loop sensor and +130V at J3-10 from contacts CS-3 set the CG flip-flop, changing J3-5 to logic 0. This is returned to the central office on the B signaling path as a coin present indication.

4.49 After CS releases, contacts CS-3 switch the voltage at J3-10 to −130V, removing the set condition from the CG flip-flop, which remains set, however.

4.50 The loop sensor follows dial pulsing, but time delay (not shown) in the circuit holds J3-13 at logic 0 and the CS relay does not operate. At the end of the call, the CF relay is released by a coin collect command or coin return command from the central office. The resulting change to logic 1 at J3-9 holds or produces logic 0 at J3-13. Because of delay (not shown) at the input to U25C, this change does not affect the CG flip-flop. Meanwhile, a coin ground at the paystation will cause the CC (coin control) relay to operate. Contacts CC-1 close logic 1 to U25C, preventing reset of the CG flip-flop and the coin present indication remains in effect.

4.51 If the coin is collected or returned at the paystation, upon the next application of coin voltage (+130V or −130V), relay CC will not operate. After delay, logic 1 at J3-9 resets the CG flip-flop, J3-5 goes to logic 1, and no coin present indication is returned to the central office.

4.52 On an incoming call, because CS is normally operated, the tip side of the subscriber loop is open and an off-hook at the paystation will not be detected by the loop sensor. Instead, off-hook must be detected by the ring trip circuit during ringing as follows. Through gate 2, J3-3 goes to logic 1. Through U25A, J3-13 goes to logic 0, releasing the CS relay to provide normal battery feed and supervision of the call by the loop sensor.

4.53 Released contacts CS-3 place −130V at J3-10 to inhibit setting of the CG flip-flop. This is to prevent the next call from being free, since a coin collect or coin return command is not sent from the central office upon completion of a terminating call. Therefore, the CF relay does not operate and the CG flip-flop would not be reset by a logic 1 at J3-9.

4.54 Code A of the 91266 Channel Unit. When the 91266 channel unit is equipped with code A, TCMF Disable Subassembly 087-55378-01 is plugged into J4 in place of Through-Strap Plug Assembly 087-56146-01. See figure 4-7. When the operator comes on the line, via the B6 signaling bit, positive battery feed (+48V from an optional power converter) is applied to the ring side of the subscriber loop to disable the TCMF pad in the paystation.

4.55 Refer to figure 4-6C. Logic 1 on RCS at J4-11 sets the PV flip-flop when clocked at signaling bit B6 time at J4-15. (If the signaling B subdemultiplexer in the A/B decoder is not synchronized, the reset input to the flip-flop at J4-10 will be activated.) When the flip-flop is set, the PV (polarity voltage) relay operates. Contacts PV-1, -2, -3, and -5 switch the ring side of the loop from −48V to +48V while maintaining the same polarity to the loop sensor.

4.56 Because the output voltages from the loop sensor are affected by the change from −48V to +48V, an interface circuit is used between J4-12 and J4-2. In conjunction with contacts PV-4, the interface circuit provides the same logic levels at J4-2 for either position of the PV relay.

4.57 The balanced coin detector subassembly used with the 91266-01 channel unit detects positive voltage changes. To prevent a false coin present indication when the PV relay operates, contacts PV-6 close ground through plug P5 to J3-12, disabling the output of the tip-ground detector (figure 4-6A). This is acceptable because the operator will be on the line at this time, receiving audible indications of coins deposited.

4.58 Removal of Subscriber Channel Unit. Unplugging the 91266 channel unit leaves TCS-A and TCS-B at logic 1, received by the office channel unit as off-hook and coin present indications, respectively.

91268 Semi-Postpay Subscriber Channel Unit

4.59 The 91268 channel unit (figure 4-8) provides paystation or regular single-party subscriber line service with bridged ringing and reverse battery supervision. The units can also be used for hotel/motel lines requiring message metering. The remote 91268 channel unit works with the 91269 Semi-Postpay Office Channel Unit at the central office terminal. Differences from the 91260 channel unit (paragraph 4.08) are described in the paragraphs that follow.

4.60 Receive Signaling. Through the A/B decoder, the A and B signaling bits control ringing and loopback testing. However, the A and B signaling conditions that operate the RR relay will operate the F relay instead if the loop sensor is indicating off-hook. Thus, the RR relay operates on terminating (incoming) calls and the F relay on originating (outgoing) calls. When activated, the ring trip circuit releases the RR relay or prevents operation of the F relay.

4.61 When a call is originated at a station and the called party answers, the central office sends a command to operate the F relay. This reverses the polarity of the battery feed to the subscriber loop. At the paystation, this reversal disables the talk circuit until the required coins have been deposited. Normal battery feed is restored when either party disconnects.

4.62 Ringing. In the normal (non-test) mode, operation of the RR relay diverts sine-wave ringing signals from the vf receive branch through a squaring amplifier and driver to the RC chopper relay. Contacts RC-1 switch the ring side of the loop between ground and −260V or −310V at the frequency received on the vf path, generating a unipolar square-wave that actuates the station ringer.

91261 Bridged Ringing Office Channel Unit

4.63 The 91261 channel unit (figure 4-9) operates at a central office terminal with a 91260 channel unit at a remote terminal. The description below of the 91261 channel unit is also applicable as background for the descriptions in this Part of other office-type channel units. Basic elements common to all channel units were covered previously at the beginning of this Part.

4.64 VF Transmission. The two-wire vf path is normally open at relay contacts P-1. Mute circuits connected to the vf transmit and vf receive branches are not activated.

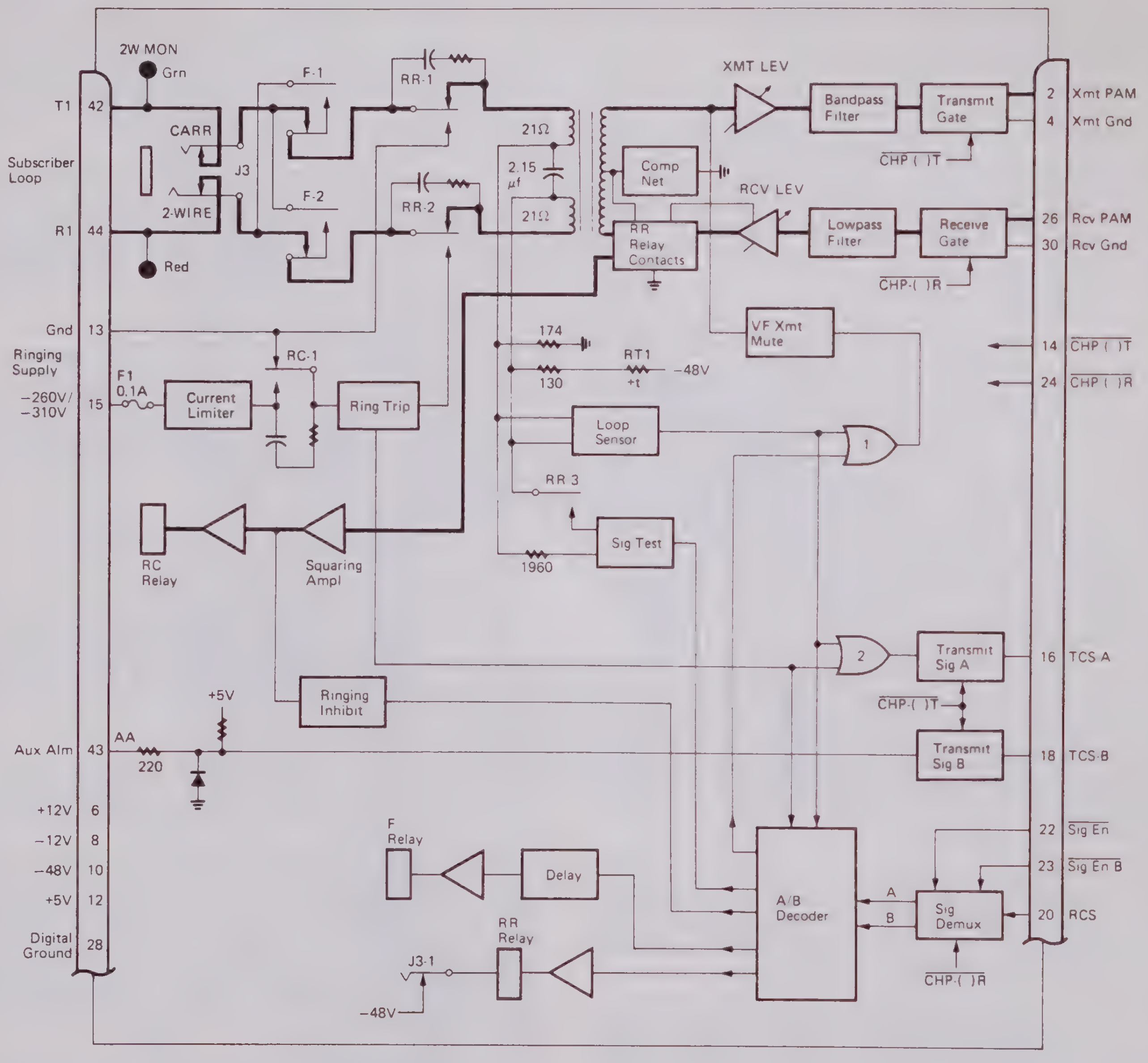
4.65 Transmit Signaling. Ringing signals on the two-wire drop from the central office equipment go through an attenuator and ringing gate to the transmit gate input. At the same time, a ringing-present signal from the ringing detector enables the ringing gate and mutes the vf transmit branch ahead of the amplifier. Through the signaling submultiplexer, a ringing command is sent to the subscriber channel unit on the A signaling path.

4.66 At the remote terminal, capacitance in the two-wire subscriber loop may have a residual charge at the end of a ringing period; occasionally, discharge current through the subscriber channel unit will be sensed falsely as an off-hook condition. In the office channel unit, if the A signaling path is indicating on-hook just as the ringing-present signal from the detector ends, P relay operation is inhibited for about 100 milliseconds. This is the period in which a false trip off-hook signal from the subscriber channel unit would be received.

4.67 When the NORM/TEST switch is placed in TEST position, a loopback command is transmitted on the B signaling path and the A signaling path is allocated to transmission of dial pulses as part of the remote-looped signaling test.

4.68 Receive Signaling. On-hook and off-hook signals (and dial pulses) are received on the A signaling path and auxiliary alarm indications on the B signaling path. An off-hook signal from the subscriber channel unit inhibits the ringing gate so that if a ringing signal is being applied to the transmit gate, it will be tripped. Except as in the preceding paragraph, the P relay operates without delay to close the loop and trip the

Figure 4-8. 91268 Semi-Postpay Subscriber Channel Unit, Circuit Diagram


2W MON
Grn
Red
T1
R1
Subscriber Loop
42
44
CARR
2-WIRE
J3
F-1
F-2
RR-1
RR-2
21Ω
2.15 µf
21Ω
XMT LEV
RCV LEV
Comp Net
RR Relay Contacts
Bandpass Filter
Transmit Gate
Lowpass Filter
Receive Gate
CHP ( )T
CHP-( )R
2 Xmt PAM
4 Xmt Gnd
26 Rcv PAM
30 Rcv Gnd
Gnd 13
Ringing Supply
−260V/ −310V 15
F1 0.1A
Current Limiter
RC-1
Ring Trip
174
130
RT1
+t
−48V
VF Xmt Mute
14 CHP ( )T
24 CHP ( )R
Loop Sensor
1
RR 3
Sig Test
1960
RC Relay
Squaring Ampl
2
Transmit Sig A
16 TCS A
Ringing Inhibit
CHP-( )T
Transmit Sig B
18 TCS-B
+5V
AA
220
Aux Alm 43
+12V 6
−12V 8
−48V 10
+5V 12
Digital Ground 28
F Relay
Delay
RR Relay
J3-1
−48V
A/B Decoder
A
B
Sig Demux
CHP-( )R
22 Sig En
23 Sig En B
20 RCS

Notes:

1. High Voltage Warning: High ringing voltage may be encountered on exposed printed circuits. Avoid contact with printed circuits when installing or removing channel units and for several seconds after removal.

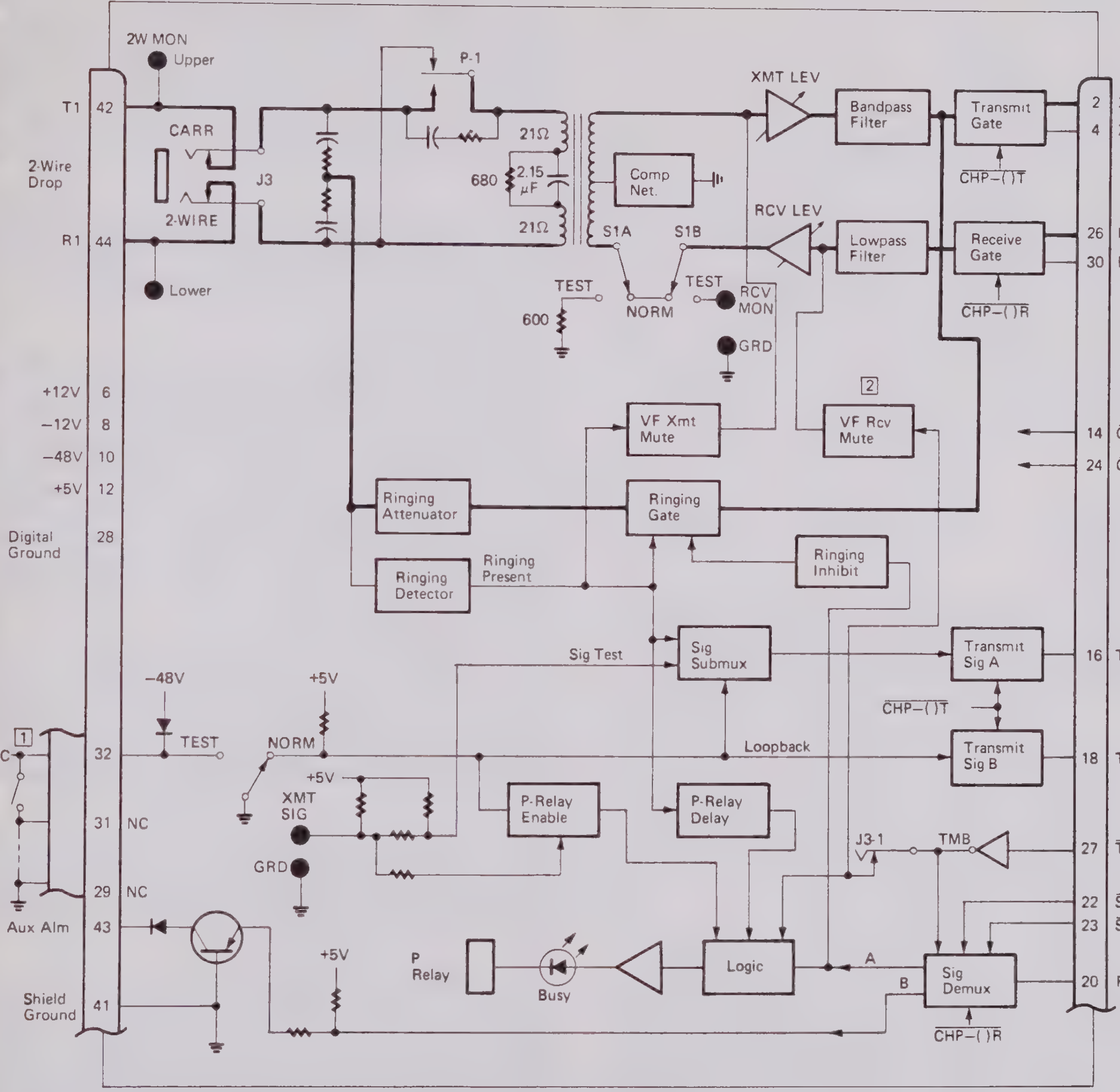
office ringing. The BUSY indicator lights when the P relay is energized. Dial pulses are repeated by relay contacts P-1. The capacitor and resistor across the contacts provide protection and also give the proper dynamic pulsing characteristics to the office relay.

4.69 In the idle channel state, contacts P-1 short the hybrid transformer, blocking incoming ringing voltage from the vf circuits. Although this short destroys the transhybrid balance, a vf receive mute at the remote subscriber channel unit prevents singing.

4.70 Remote Looped Testing. In TEST position, switch section S1C grounds the C lead to prevent intrusion by office equipment (if the equipment is so wired) and sends a loopback command to the subscriber channel unit on the B signaling path. Also, through the P-relay enable circuit (with an open at the XMT SIG jack), the P relay is operated to close the two-wire vf path. Switch sections S1A and S1B open the four-wire receive branch at the hybrid transformer and terminate the transformer in 600 ohms. Now, vf signals inserted at the CARR 2-WIRE telephone jack are transmitted to the remote terminal, looped back by the subscriber channel unit there, and return to the RCV MON and GRD pin jacks.

4.71 Signaling can be tested by battery/ground M-lead pulsing with a GTE Lenkurt 26600 Signaling Test Set connected to the XMT SIG and GRD pin jacks. With switch S1 in TEST position, the signaling submultiplexer is conditioned

Figure 4-9. 91261 Bridged Ringing Office Channel Unit, Circuit Diagram


2W MON
Upper
Lower
T1
R1
2-Wire Drop
42
44
CARR
2-WIRE
J3
P-1
21Ω
680
2.15 μF
21Ω
Comp Net.
S1A
S1B
TEST
600
NORM
TEST
RCV MON
GRD
XMT LEV
Bandpass Filter
Transmit Gate
CHP—( )T
RCV LEV
Lowpass Filter
Receive Gate
CHP—( )R
2 Xmt PAM
4 Xmt Gnd
26 Rcv PAM
30 Rcv Gnd
+12V 6
−12V 8
−48V 10
+5V 12
Digital Ground 28
VF Xmt Mute
2
VF Rcv Mute
14 CHP—( )T
24 CHP—( )R
Ringing Attenuator
Ringing Gate
Ringing Inhibit
Ringing Detector
Ringing Present
Sig Test
Sig Submux
Transmit Sig A
16 TCS-A
CHP—( )T
Loopback
Transmit Sig B
18 TCS-B
−48V
+5V
TEST
NORM
1
C
32
31 NC
29 NC
+5V
XMT SIG
GRD
P-Relay Enable
P-Relay Delay
J3-1
TMB
27 TMB
22 Sig En
23 Sig En B
Aux Alm 43
Shield Ground 41
+5V
P Relay
Busy
Logic
A
B
Sig Demux
CHP—( )R
20 RCS

Notes:

1 C-Lead. Contacts at pins 31 and 32 on the shelf connector close when the channel unit is unplugged. If the optional C-lead busy connection at pin 32 will be used, strap pin 31 on the connector to ground at pin 28 or pin 29 according to the 91220 or 91330 shelf model and Issue numbers as follows:

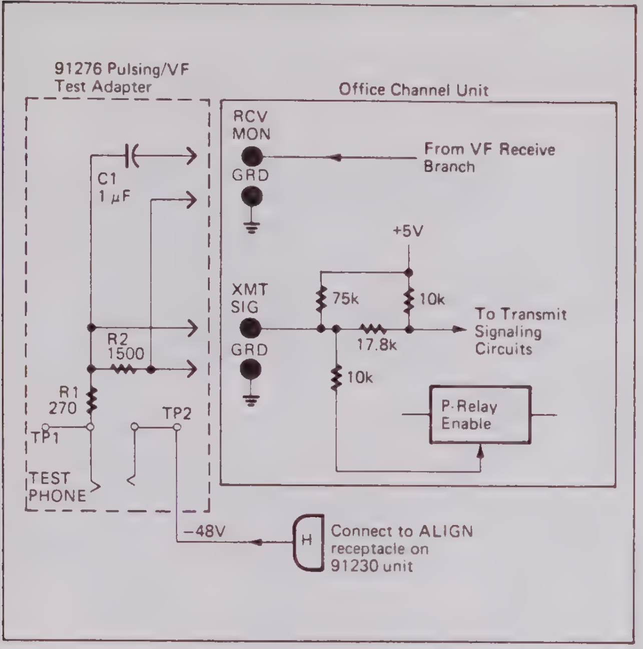
91220, models 1 and 2 and model 3 Issue 1: strap pin 31 to pin 28
91220, model 3 Issue 2 and later: strap pin 31 to pin 29
91330, model 1: strap pin 31 to pin 29

2 VF Receive Mute. Was not on 91261 prior to Issue 3.

to respond to the signaling test input instead of the ringing detector output. Respectively, ground and battery at the XMT SIG jack are transmitted as logic 1 and 0 on TCS-A. Either battery or ground disables the P-relay enable circuit, preventing P-relay operation by switch section S1C. Dial pulses sent out on the A signaling path are looped back by the subscriber channel unit and return to pulse the P relay. Pulsing distortion is measured on the test set at the CARR 2-WIRE jack.

4.72 91276 Pulsing/VF Test Adapter. In the loopback test mode, individual channels can be checked out rapidly by dialing the office milliwatt supply on a hand test telephone (butt-in), type 801 or equivalent, connected to the office channel unit through a 91276 Pulsing/VF Test Adapter. Dial pulses will be transmitted over the remote-looped channel and, if the office C-lead is not wired, test tone will be returned.

Figure 4-10. 91276 Pulsing/VF Test Adapter, Interface With Office Channel Unit



4.73 As shown in figure 4-10, the P-relay enable circuit is disabled by ground through resistor R2 (telephone on-hook) or by –48V through resistor R1 (telephone off-hook). However, the voltage presented to the transmit signaling circuits is logic 1 for on-hook and logic 0 for off-hook. The vf signal in the receive branch is monitored through capacitor C1.

4.74 System Alarm. During a system alarm, the $\overline{\text{TMB}}$ lead is grounded by the channel bank common equipment. If a channel unit is busy, through auxiliary contacts J3-1 of CARR 2-WIRE jack J3, TMB forces the P relay to release and drop the party, and mutes the vf receive path. Also, in the signaling demultiplexer, TMB forces an off-hook condition and a normal (non-alarm) auxiliary alarm condition.

4.75 Looping the channel bank at the hf line to allow local vf testing is a system alarm condition. Here, the vf receive mute prevents singing, which may occur in channel unit pairs with receive level settings of 0 dBm or higher. Singing could interfere with idle noise measurements on other channels. On the channel unit being tested when a cord is plugged into jack J3, contacts J3-1 remove the P-relay inhibit by TMB. This allows the off-hook condition forced by TMB in the signaling demultiplexer to take effect and the P relay operates, closing the two-wire vf path from jack J3 to the hybrid transformer.

4.76 Removal of Office Channel Unit. Unplugging the office channel unit results in logic 1 at the A and B outputs of the signaling demultiplexer in the subscriber channel unit. This operates the RR relay, which removes talk battery from the subscriber loop. Ringing does not occur because no ringing frequency is received.

91263 Divided Ringing Office Channel Unit

4.77 The 91263 channel unit (figure 4-11) operates at a central office terminal with a 91262 channel unit at a remote terminal. Differences from the 91261 channel unit (paragraph 4.63) are described in the following paragraphs.

NOTE: The vf receive branch of the 91263 channel unit does not include a mute circuit.

4.78 Transmit Signaling. In the normal mode, during an idle channel condition, both TCS-A and TCS-B are logic 0 at transmit channel pulse time. When ringing on the two-wire drop is detected, a ringing command is transmitted on TCS-A as logic 1 and ringing party identification is sent on TCS-B as logic 1 (tip party) or logic 0 (ring party). Regardless of the instant at which ringing is detected, the ringing command goes out on TCS-A in a frame 6 preceding the ringing party identification signal on TCS-B in frame 12. This sequence enables the subscriber channel unit to distinguish between a ringing command and a loopback command for remote-looped testing.

4.79 Several timing signals used in the signaling submultiplexer are derived from the frame sync pulse occurring every 1500 µs at frame 6 time. Here the pulse is used merely as a digital timing source and does not have any synchronization function.

4.80 Receive Signaling. On-hook and off-hook signals (and dial pulses) are received on the A signaling path and time-multiplexed ANI/auxiliary alarm signals on the B path. In the signaling B subdemultiplexer, ANI and auxiliary alarm conditions are stored in separate flip-flops. Ordinarily, incoming alarm status information is directed to the alarm flip-flop, but when a loop transition is received on the A path, the alarm flip-flop is held in its existing state for about 26 milliseconds. During this period, for about 9 milliseconds, ANI signals on the B path are sampled and directed to the ANI flip-flop. A tip-party ANI signal causes the ANI relay to operate and apply a simplex resistive ground to the two-wire drop.

4.81 Remote-Looped Testing. When NORM/TEST switch S1 is placed in the TEST position, a loopback command is sent to the subscriber channel unit as logic 1 on TCS-B. But first, ringing command and ringing party identification are inhibited for about 90 milliseconds to allow the subscriber channel unit to reset to an idle condition. The A signaling path is then assigned to dial pulse signaling tests.

4.82 If a system alarm is received on $\overline{\text{TMB}}$ while the 91263 channel unit is in the loopback test mode, TCS-A is forced to logic 0. This is done so that when the system restores from the alarm condition, the remote subscriber channel unit will latch into the loopback test mode.

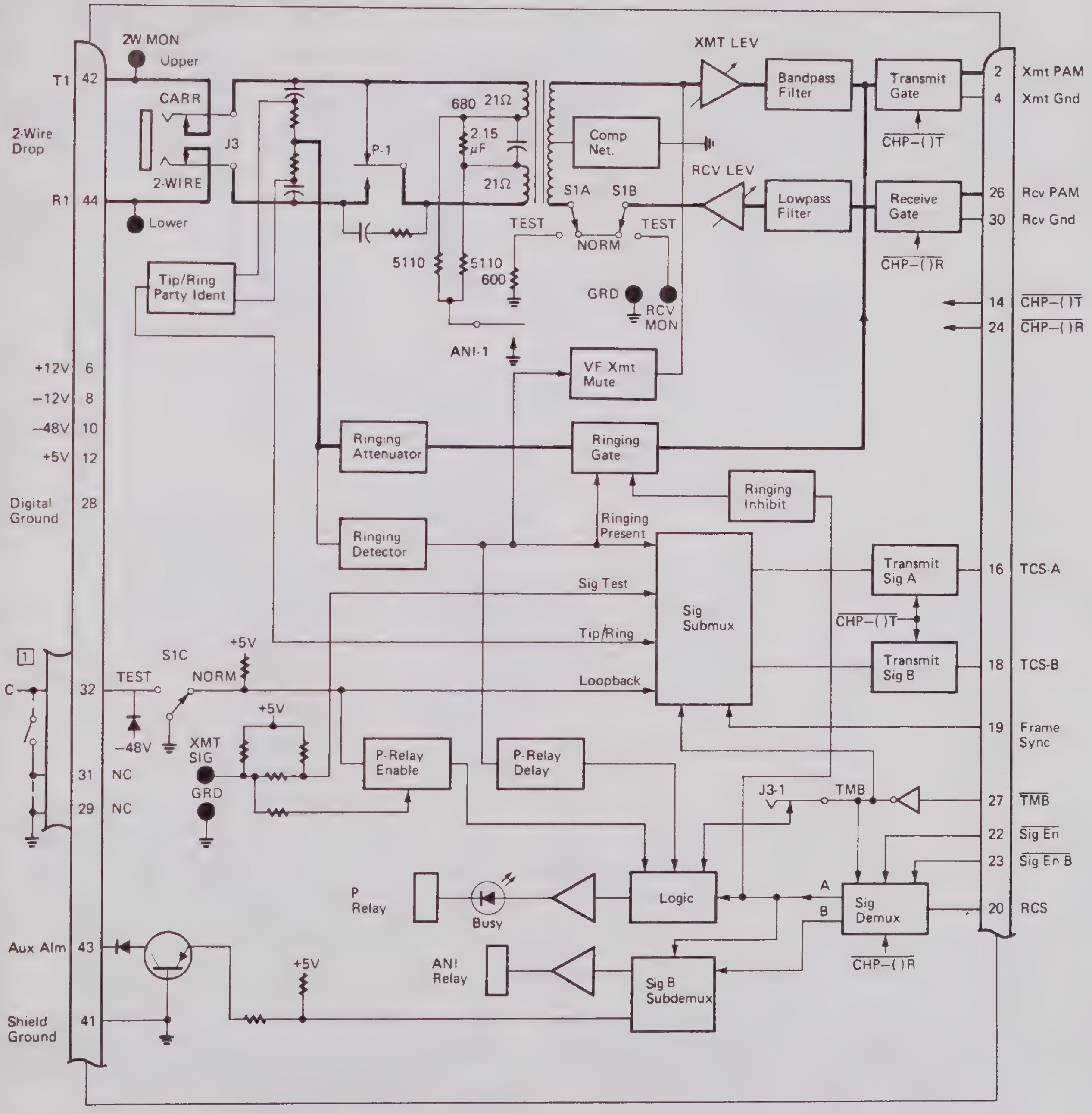
4.83 Removal of 91263 Channel Unit. The 91263 channel unit should be monitored before it is removed from the shelf. If it is unplugged during ringing, TCS-A will remain at logic 1, holding the remote subscriber channel unit in the ringing mode. In this condition, the ringing chopper may respond intermittently to noise on the vf channel. Removing the 91263 channel unit while it is in the idle or loopback test mode will cause the subscriber channel unit to latch in the test mode.

91265 Superimposed Ringing Office Channel Unit

4.84 The 91265 channel unit (figure 4-12) operates at a central office terminal with a 91264 channel unit at a remote terminal. Differences from the 91261 channel unit (paragraph 4.63) are described below.

4.85 Transmit Signaling. During ringing, the central office switching equipment applies ground to one lead of the two-wire drop and an ac voltage superimposed on a bias of about +40V or –40V to the other lead. In the 91265 channel unit, polarity of the bias and tip/ring ringing are detected and passed to the signaling submultiplexer. Here the information is time multiplexed in a subframe of eight consecutive B signaling bits. Four bits are used to synchronize the subframe and the other four bits are assigned as follows: B1, ringing

Figure 4-11. 91263 Divided Ringing Office Channel Unit, Circuit Diagram

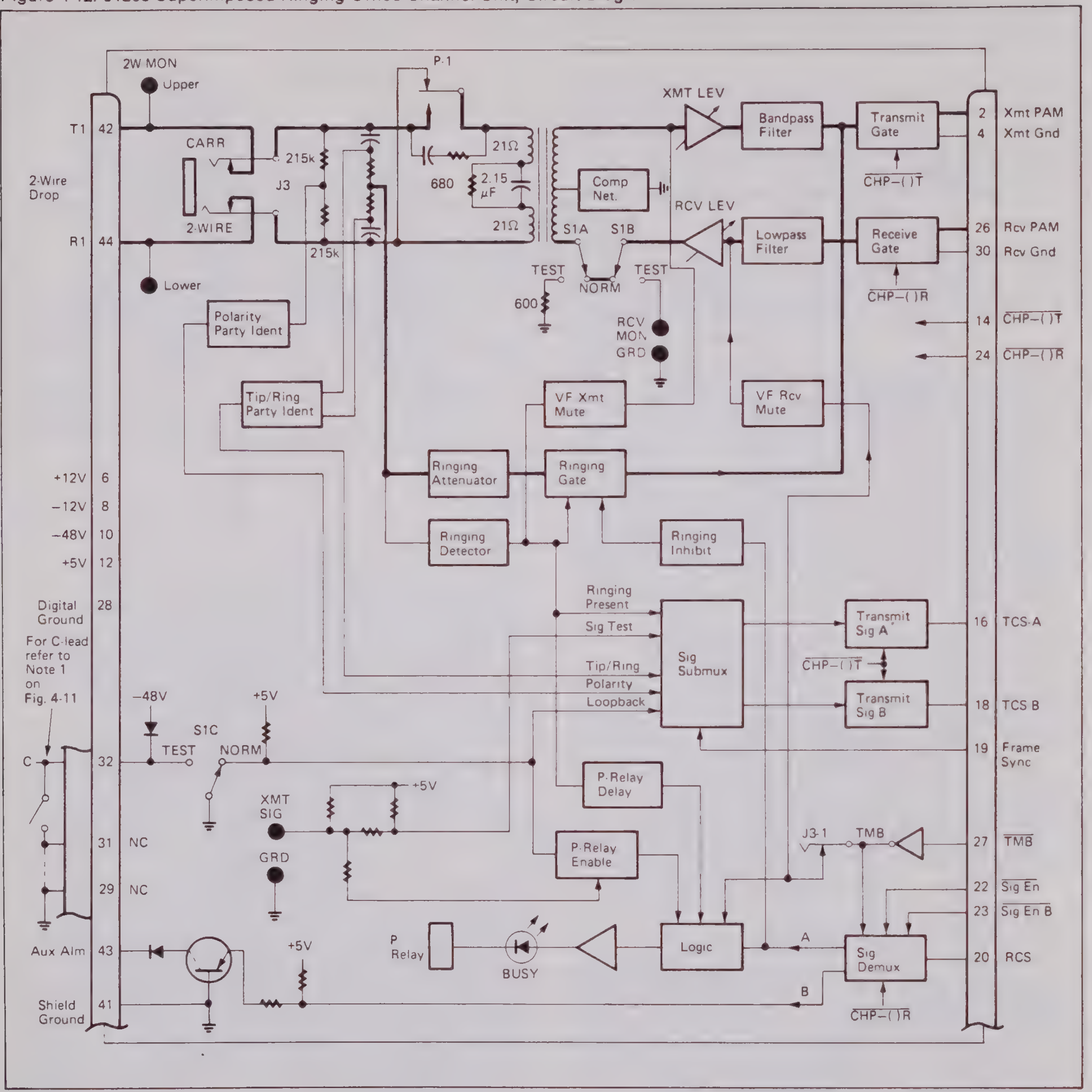

2W MON
Upper
T1 42
CARR
2-Wire Drop
J3
2-WIRE
R1 44
Lower
XMT LEV
Bandpass Filter
Transmit Gate
2 Xmt PAM
4 Xmt Gnd
680 21Ω
2.15 μF
21Ω
P-1
Comp Net.
CHP–( )T
RCV LEV
S1A S1B
Lowpass Filter
Receive Gate
26 Rcv PAM
30 Rcv Gnd
TEST
NORM
TEST
CHP–( )R
5110
5110
600
Tip/Ring Party Ident
GRD
RCV MON
14 CHP–( )T
24 CHP–( )R
ANI-1
VF Xmt Mute
+12V 6
–12V 8
–48V 10
+5V 12
Ringing Attenuator
Ringing Gate
Digital Ground 28
Ringing Inhibit
Ringing Present
Ringing Detector
Transmit Sig A
16 TCS-A
Sig Test
Sig Submux
CHP–( )T
Tip/Ring
+5V
1
S1C
Transmit Sig B
18 TCS-B
TEST
NORM
Loopback
C
32
+5V
19 Frame Sync
–48V
XMT SIG
P-Relay Enable
P-Relay Delay
31 NC
J3-1
TMB
27 TMB
GRD
29 NC
22 Sig En
23 Sig En B
P Relay
Busy
Logic
A
B
Sig Demux
20 RCS
Aux Alm 43
+5V
ANI Relay
CHP–( )R
Sig B Subdemux
Shield Ground 41

Notes:

1 C-Lead. Contacts at pins 31 and 32 on the shelf connector close when the channel unit is unplugged. If the optional C-lead busy connection at pin 32 will be used, strap pin 31 on the connector to ground at pin 28 or pin 29 according to the 91220 or 91330 shelf model and Issue numbers as follows:

91220, models 1 and 2 and model 3 Issue 1: strap pin 31 to pin 28
91220, model 3 Issue 2 and later: strap pin 31 to pin 29
91330, model 1: strap pin 31 to pin 29

Figure 4-12. 91265 Superimposed Ringing Office Channel Unit, Circuit Diagram


2W MON
Upper
P-1
XMT LEV
T1
42
CARR
215k
21Ω
Bandpass Filter
Transmit Gate
2
Xmt PAM
4
Xmt Gnd
2-Wire Drop
J3
680
2.15 μF
Comp Net.
CHP–( )T
RCV LEV
2-WIRE
21Ω
S1A
S1B
Lowpass Filter
Receive Gate
26
Rcv PAM
30
Rcv Gnd
R1
44
215k
TEST
TEST
NORM
CHP–( )R
Lower
600
14
CHP–( )T
Polarity Party Ident
RCV MON
GRD
24
CHP–( )R
Tip/Ring Party Ident
VF Xmt Mute
VF Rcv Mute
+12V
6
Ringing Attenuator
Ringing Gate
–12V
8
–48V
10
Ringing Detector
Ringing Inhibit
+5V
12
Digital Ground
28
Ringing Present
For C-lead refer to Note 1 on Fig. 4-11
Sig Test
Transmit Sig A
16
TCS-A
Sig Submux
CHP–( )T
Tip/Ring
Polarity
Loopback
Transmit Sig B
18
TCS B
–48V
+5V
S1C
TEST
NORM
19
Frame Sync
C
32
+5V
P-Relay Delay
XMT SIG
31
NC
J3-1
TMB
27
TMB
GRD
P-Relay Enable
29
NC
22
Sig En
23
Sig En B
+5V
P Relay
A
Aux Alm
43
Logic
Sig Demux
20
RCS
BUSY
B
Shield Ground
41
CHP–( )R

polarity; B2, unassigned; B3, tip/ring ringing; and B4, loopback command. A divide-by-eight counter in the submultiplexer is advanced every 1500 μs by frame sync pulses.

91267 Full-Prepay Office Channel Unit

4.86 The 91267 channel unit (figure 4-13) operates at a central office terminal with a 91266 channel unit at a remote terminal. Differences from the 91261 channel unit (paragraph 4.63) are described in following paragraphs.

4.87 Transmit Signaling. When the NORM/TEST switch is placed in TEST, a loopback command is transmitted on the B signaling path. By enabling of NAND gate 1, the A signaling path is allocated to transmission of dial pulses as part of the remote-looped signaling test.

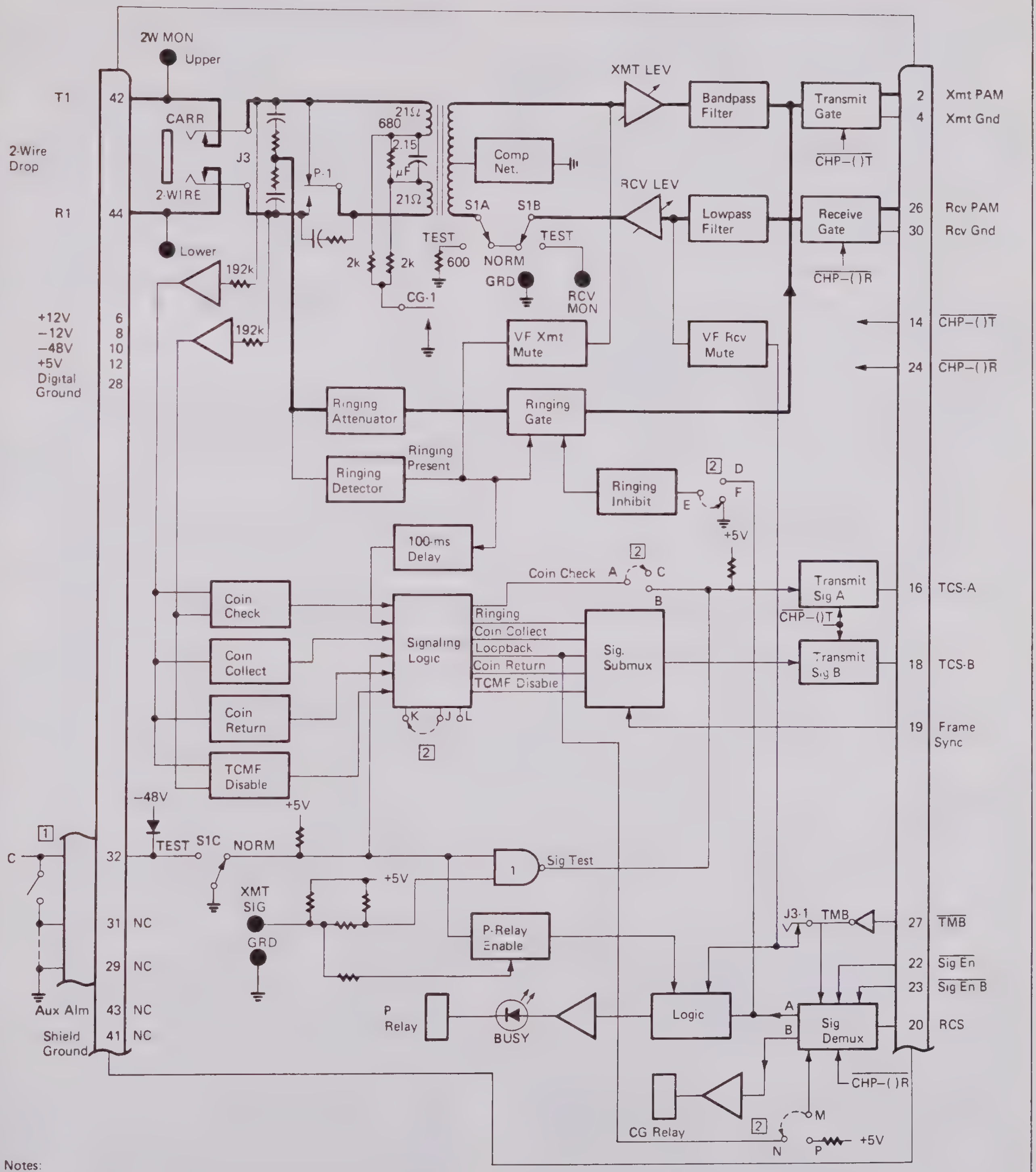
4.88 Voltages on the tip and ring of the two-wire drop are monitored separately by four sensors, activated under the following conditions.

(a) Coin collect: +90V to +135V on the tip with the ring open or connected to the tip.

(b) Coin return: –90V to –135V on the tip with the ring open or connected to the tip.

(c) TCMF (touch-call multifrequency) disable: +50V on the ring with the tip grounded, or reverse battery.

4.89 In the signaling submultiplexer, a subframe of 10 consecutive B signaling bits is time multiplexed. Four bits are used to synchronize the subframe and six bits are assigned to the transmission of the following commands: B1, ringing; B2, coin collect; B3, loopback; B4, coin return; B5, Figure 4-13. 91267 Full-Prepay Office Channel Unit, Circuit Diagram


2W MON
Upper
Lower
T1
R1
2-Wire Drop
42
44
CARR
2-WIRE
J3
21Ω
680
2.15 μF
21Ω
P-1
2k
2k
600
CG-1
TEST
NORM
GRD
TEST
RCV MON
S1A
S1B
Comp Net.
XMT LEV
RCV LEV
Bandpass Filter
Lowpass Filter
Transmit Gate
Receive Gate
CHP–( )T
CHP–( )R
2 Xmt PAM
4 Xmt Gnd
26 Rcv PAM
30 Rcv Gnd
14 CHP–( )T
24 CHP–( )R
192k
192k
+12V 6
–12V 8
–48V 10
+5V 12
Digital Ground 28
VF Xmt Mute
VF Rcv Mute
Ringing Attenuator
Ringing Gate
Ringing Present
Ringing Detector
Ringing Inhibit
2 D
E
F
+5V
100-ms Delay
2
Coin Check A
C
B
Transmit Sig A
CHP–( )T
16 TCS-A
Transmit Sig B
18 TCS-B
19 Frame Sync
Coin Check
Coin Collect
Coin Return
TCMF Disable
Signaling Logic
Ringing
Coin Collect
Loopback
Coin Return
TCMF Disable
Sig. Submux
K J L
2
–48V
+5V
1
C
32
TEST
S1C
NORM
Sig Test
1
XMT SIG
GRD
+5V
31 NC
29 NC
43 NC
41 NC
Aux Alm
Shield Ground
P-Relay Enable
J3-1
TMB
27 TMB
22 Sig En
23 Sig En B
20 RCS
P Relay
BUSY
Logic
A
B
Sig Demux
CHP–( )R
CG Relay
2
M
N
P
+5V

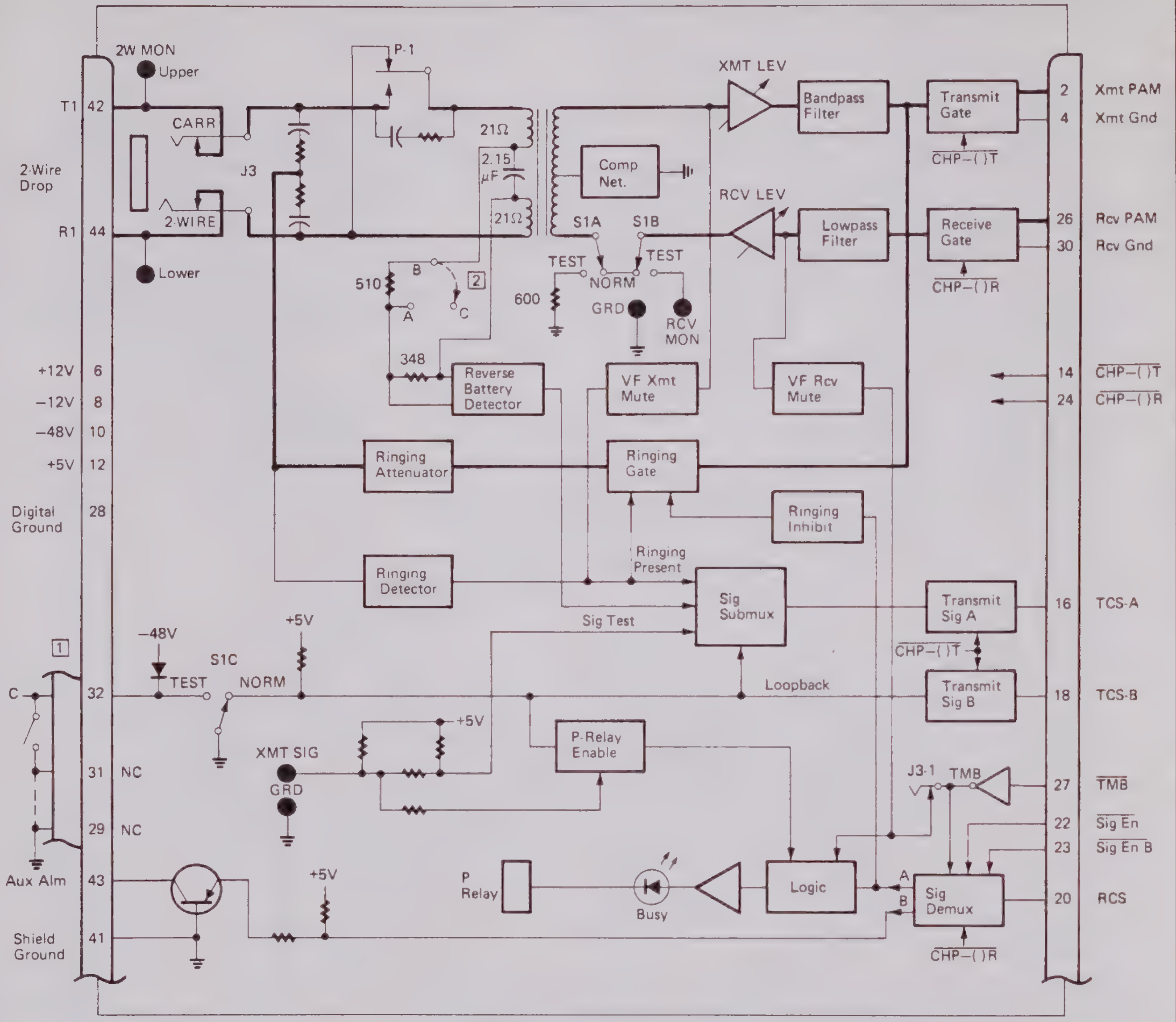
Notes:

1 **C-Lead.** Contacts at pins 31 and 32 on the shelf connector close when the channel unit is unplugged. If the optional C-lead busy connection at pin 32 will be used, strap pin 31 on the connector to ground at pin 28 or pin 29 according to the 91220 or 91330 shelf Model and Issue numbers as follows:

91220, Models 1 and 2 and Model 3 Issue 1: strap pin 31 to pin 28
91220, Model 3 Issue 2 and later: strap pin 31 to pin 29
91330, Model 1: strap pin 31 to pin 29

2 **Channel Unit Strapping.** Strap the 91267 channel unit A-C, M-N, E-F, J-K. This is factory strapping.

Figure 4-14. 91269 Semi-Postpay Office Channel Unit, Circuit Diagram


2W MON
Upper
Lower
T1
R1
42
44
2-Wire Drop
CARR
2-WIRE
J3
P-1
21Ω
2.15 μF
21Ω
XMT LEV
RCV LEV
Bandpass Filter
Lowpass Filter
Transmit Gate
Receive Gate
CHP—( )T
CHP—( )R
Comp Net.
S1A
S1B
TEST
TEST
NORM
GRD
RCV MON
510
348
600
A
B
C
2
Reverse Battery Detector
VF Xmt Mute
VF Rcv Mute
Ringing Attenuator
Ringing Gate
Ringing Inhibit
Ringing Present
Ringing Detector
Sig Submux
Sig Test
Loopback
Transmit Sig A
Transmit Sig B
P-Relay Enable
XMT SIG
GRD
Logic
Busy
P Relay
J3-1
TMB
Sig Demux
+12V
−12V
−48V
+5V
Digital Ground
1
C
Aux Alm
Shield Ground
S1C
TEST
NORM
−48V
+5V
+5V
+5V
6
8
10
12
28
32
31
NC
29
NC
43
41
2
4
26
30
14
24
16
18
27
22
23
20
Xmt PAM
Xmt Gnd
Rcv PAM
Rcv Gnd
CHP—( )T
CHP—( )R
TCS-A
TCS-B
TMB
Sig En
Sig En B
RCS

Notes:

[1] C-Lead. Contacts at pins 31 and 32 on the shelf connector close when the channel unit is unplugged. If the optional C-lead busy connection at pin 32 will be used, strap pin 31 on the connector to ground at pin 28 or pin 29 according to the 91220 or 91330 shelf model and Issue numbers as follows:

91220, models 1 and 2 and model 3 Issue 1: strap pin 31 to pin 28
91220, model 3 Issue 2 and later: strap pin 31 to pin 29
91330, model 1: strap pin 31 to pin 29

[2] 2-Wire Drop. Strap the channel unit according to the dc loop resistance of the 2-wire drop to the office.

Loop Resistance	Strap
More than 500 ohms	A-B
500 ohms or less	B-C*

*Factory strapping, unless otherwise specified.

unassigned; B6, TCMF disable. A decade counter in the submultiplexer is advanced every 1500 μs by frame sync pulses.

4.90 The NORM/TEST switch in TEST position inhibits the other five inputs to the signaling logic circuits. Ringing inhibits the inputs from the four sensors on the two-wire drop. To prevent interference with an existing coin collect or coin return command, the ringing present signal is delayed for 100 milliseconds. Coin collect or coin return inhibits TCMF disable. The TCMF disable feature is implemented by strapping J-K.

4.91 Receive Signaling. Instead of auxiliary alarms, coin present indications are received from the remote subscriber channel unit on the B signaling path. When the CG (coin ground) relay operates in response to a coin present indication, contacts CG-1 close the two-wire drop through a balanced 1000-ohm path to ground.

4.92 On the 91267 channel unit, use of the ringing inhibit circuit as a local ring-trip is a strapping option (D-E instead of E-F).

▶4.93 Other straps which are present on the unit are for possible future applications. These straps should be as shown in figure 4-13.◀

91269 Semi-Postpay Office Channel Unit

4.94 The 91269 channel unit (figure 4-14) operates at a central office terminal with a 91268 channel unit at a remote terminal. Differences from the 91261 channel unit (paragraph 4.63) are described below.

4.95 Transmit Signaling. When the NORM/TEST switch is in NORM position, on outgoing calls to the subscriber, ringing commands are transmitted to the remote subscriber channel unit on the A signaling path. On incoming calls, when the called party answers, the central office reverses the polarity of the battery feed on the two-wire drop. This is sensed by the reverse battery detector and forwarded as a command to the subscriber channel unit on the A signaling path.

5. ENGINEERING CONSIDERATIONS

Remote Terminal

5.01 Housing vs Office Installation. Generally, the 910A housing assembly will provide the lowest-cost type of remote terminal installation. However, installation in an existing office or a customer-furnished shelter may be preferable because of one or more of the following.

(a) Multiple housings would be required to accommodate the initial number of circuits or the expected growth.

(b) Access to the equipment and on-site maintenance would be difficult during extreme weather conditions.

(c) A large standby battery capacity would be required because of: an extreme and prolonged low-temperature environment; poor reliability of commercial ac power; or relatively long travel time if an emergency ac generator is needed at the site.

5.02 Siting. Wherever possible, the remote terminal should be located on an existing pcm repeatered line route. Subscriber loops from the remote terminal require a loading design just like loops from a central office. By placing the remote terminal exactly halfway between loading points on a loaded cable, minimum end-section buildout will be needed for loaded subscriber loops in the same cable. Sites should be easily accessible and not subject to flooding or snow buildup.

5.03 Placement of the housing near existing structures should be considered for concealment and protection against vehicular traffic and road maintenance operations. If the housing will be used in the vented mode, the front should face in a direction that will minimize the ingestion of dirt through the intake vent; for example, away from the adjacent road. In a very hot climate, placing the narrow end of the housing toward the afternoon sun will contribute to a lower inside temperature. Where more than one housing will be required at the same site, a common foundation can be designed on the basis of dimensions given on figure 8-3.

5.04 Availability of commercial ac power (single-phase, 117V at 60 Hz ± 2 Hz) is an important factor. Service should be ordered early so that power can be used during the installation phase. Maximum load on the two branch circuits in the Model 2 housing is 400 watts (battery chargers) through CB1 and up to 1500 watts (convenience outlets) through CB2. On the Model 1 housing (manufacture discontinued), maximum load is 400 watts (battery chargers) and 1700 watts (heater and outlets).

NOTE: Another power option for foreign countries is single-phase, 220V at 50 Hz ± 2 Hz.

5.05 Grounding should be in accordance with operating company protection standards; there are no special requirements applicable to the 910A housing assembly. A ground rod is included in the foundation plan on figure 8-3.

5.06 Two-Wire Loops. Maximum conductor loop resistances at the office end and the subscriber end (excluding telephone) are listed in figures 5-1 and 5-2. Up to the nominal values in figure 5-2, channels will meet pulsing, ringing, and transmission loss objectives. From nominal to typical values, channels will provide usable service without loop extenders in many applications. Channel units are factory adjusted to 0 dB (± 0.5 dB) net loss and usually will not require field adjustment except on special subscriber loops.

5.07 Ringing. The high third-harmonic component of the modified square wave produced by the subscriber channel units prohibits party-line usage of ringer frequencies that are related by the third harmonic. Also, because ringer sensitivity decreases at higher frequencies, the highest frequency ringer may not have enough volume on the longest loops. The recommended ringer frequencies, in order of preference within each series, are listed below for bridged and divided ringing.

(a) Harmonic series: 25, 33-1/3, 50, and 66-2/3 Hz
(b) Decimonic series: 20, 30, 40, and 50 Hz
(c) Synchromonic series: 20, 30, 42, and 54 Hz

5.08 Ringing frequency ranges for other types of subscriber channel units are:

(a) Superimposed ringing: 20 to 66-2/3 Hz
(b) Paystation: 20 to 33-1/3 Hz

5.09 Ringing capacity of subscriber channel units for maximum conductor loops (excluding telephone) at the subscriber end is shown in figure 5-3.

5.10 Ringing Supply. In a remote office installation, ringing supply voltage (– 260V/ – 310V) is obtained from two or three 91272 Power Supply Units in a load-sharing configuration as shown in figure 10-5B. Because of the low duty cycle, up to six channel banks can be handled by two 91272 units with a one-unit redundancy. For eight channel banks, three 91272 units are required. The multiple connections between 91272 units should be confined to the same 91270 shelf.

5.11 Battery Capacity. The 910A (Model 1) housing assembly equipped with 9002A channel banks may be equipped with one, two, or three sets of four gelled-electrolyte batteries. Due to the decreased power requirements of the 9002B channel banks (Model 1 and 2 housings), the number of sets of gelled-electrolyte batteries has been reduced to one or two. Each gelled-electrolyte set has a nominal rate capacity of 20 ampere-hours (8-hour discharge rate) at 40°C (104°F). Battery capacity is less at lower temperatures. With the housing vented, the battery compartment will be about the same as the outside temperature. If the housing is sealed, battery temperature will stay above 0°C (32°F) at about – 28.9°C (– 20°F) outside.

5.12 If the use of alternate type batteries is desired in the 55910 Model 2 housing, a recommended alternative is to use four non-venting (lead calcium), maintenance free automotive-type batteries, size no. 72. These batteries provide a 40-60 ampere-hour (approximate) capacity. Another recommended alternative is the maintenance-free automotive-type battery, size no. 74. These batteries provide a 60-80 ampere-

Figure 5-1. Maximum Conductor Loop Resistance at Office End (1200-ohm office)

Channel Unit	Resistance, Ohms	
	Within Channel Unit	Conductor Loop to Office
91261 BRO	730	470 [3]
91263 DRO	700 [1]	500 [3]
91265 SRO	730	150
91267 FPO	600 [2]	50
91269 SPO	400/910	800 [3]

Notes:

[1] Simplex ANI ground = 2600 ohms

[2] Simplex coin ground = 1013 ohms

[3] Conductor loop to a step-by-step office should not exceed 200 ohms because of possible increased pulsing percent break on long subscriber-end loops.

Figure 5-2. Maximum Conductor Loop Resistance at Subscriber End

Channel Unit	Resistance, Ohms	
	Nominal [1]	Typical [2]
91260 BRS	1600	2600
91262 DRS	1600	2000
91264 SRS	1600	2600
91266-01 FPS	1600	2200
91266-03 FPS	1200	1800
91268 SPS	1600	2600

Notes:

[1] Meets guaranteed pulsing specifications.

[2] Will provide usable service where pulsing performance is not critical and ringer load is in accordance with Figure 5-3.

hour (approximate) capacity; however, installation and air filter maintenance are more difficult. The automotive-type batteries can be purchased locally.

5.13 The effects of temperature and age on batteries for use with 9002A (Model 1 housings) channel banks are included in figure 5-4. Figure 5-5 shows the effects of temperature and age on batteries for use with 9002B channel banks. The figures list hours of battery operation available after an ac power failure for a 910A housing equipped with one or two channel banks and one, two, or three battery sets, depending on which model housing and which type of channel bank and battery are used. Decrease in capacity of 10 percent per year of battery age can be assumed. Hours shown in figures 5-4 and 5-5 are for battery cutoff at 36 volts. Hours until low battery alarm at 44 volts are 75 percent of figures 5-4 and 5-5. The load current referred to in figure 5-5 includes standby current for the channel bank, ringing power supply, and the 9101C office repeaters. Figures 5-4 and 5-5 do not include the current required to power the span line. When the optional 91272-01 span power supply is equipped, it requires an additional 1.2 amperes to produce 130 Vdc at 300 mA or 1.8 ▶ amperes to produce 260 Vdc at 300 mA. The low power 60 mA repeater requires about 60 percent of this current.◀

5.14 External Battery. When a larger ampere-hour capacity is required, an external battery can be installed in an underground concrete box adjacent to the 910A housing assembly. For example, a typical communications-type battery consisting of eight 6-volt cells (Globe type 3GY-13) has a capacity of 100 Ah at an 8-hour discharge rate. These are lead-acid cells with liquid electrolyte; each cell is approximately 305 mm x 254 mm x 203 mm (12 x 10 x 8 inches) and weighs 26.3 kg (58 pounds). It is reported that in equivalent railway signaling installations, the temperature inside the battery box remains fairly constant at about 21°C (70°F) over a wide range of outside ambient air temperatures. Battery capacity decreases to about 50 percent of rated capacity after 8 years. Water must be added about every 6 months.

Figure 5-3. Ringing Capacity of Subscriber Channel Unit

Channel Unit	Parties		Maximum Conductor Loop Resistance, Ohms	Activated Ringers [1]	
				—260V [5]	—310V [5]
91260 BRS	1		1200	3	4
			1600	2	3
			2600	1	1
	4		1600		2 [2]
			2600		1 [2]
91262 DRS	2 or 4		1200	3	4
			1600	2	3
			2000	1	2
	8		1600		2 [2]
			2000		1 [2]
91264 SRS	4 [3]	2 Neg	1200	3	4
			1600	2	3
			2600	1	1
		2 Pos	1200	2	2
			1600	1	1
	8 [4]	4 Neg	1600	2	3
		4 Pos	1200	2	2
91266-01 FPS	1		1600	2	2
			2200	1	1
91266-03 FPS	1		1200	2	2
			1800	1	1
91268 SPS	1		1600	2	2
			2600	1	1

Notes:

[1] Unless otherwise noted, ringers are high-impedance straight-line or biased ringers.

[2] Frequency-selective ringers.

[3] Full-selective ringing. "Neg" and "Pos" refer to polarity of ringing voltage. One party of each polarity can be connected to tip and another to ring.

[4] Semi-selective ringing. "Neg" and "Pos" refer to polarity of ringing voltage. Two parties of each polarity can be connected to tip and two others to ring.

[5] Ringing supply voltage in the channel bank is set at —260V or —310V by strapping the 91272 Power Supply Unit. Strap for —260V except in 4-8 party frequency-selective ringing applications. (The lower voltage increases system reliability.)

5.15 With temperature held between 15.6°C and 32.2°C (60° and 90°F), the optimum float-charge voltage for a lead-acid type battery is 2.15 volts per cell, or 51.6 volts for 24 cells. The 55920 Battery Chargers in the 910A housing assembly can be adapted to supply this lower voltage by insertion of diodes in the charger output leads as shown in figure 5-6.

▶5.16 55920 Battery Charger. The capacity of the 55920 Battery Charger is 4 amperes nominal and is current limited at 5 to 6 amperes. In the 910A housing assembly, two ◀ chargers in parallel provide redundancy and fast recovery from a discharged-battery condition. When supplying up to 4 amperes, the 55920 charger does not contribute to channel idle noise. If the battery has discharged because of ac power failure, the initially higher charging current may cause the idle noise to exceed specifications for a few minutes.

5.17 A remote office installation using 55920 Battery Chargers should include a 91270 Equipment Shelf with a 91271 Fuse and Alarm Unit. The 91271 unit is designed to connect two chargers to the battery and to distribute dc power to two channel banks and associated equipment. The

Figure 5-4. Available Hours of Standby Battery Operation (Typical) Based on Load, Temperature, and Battery Age With 9002A Channel Banks

			38 °C (100 °F)			18 °C (64 °F)			0°C to —40°C (32° to —40°F)			Outside Ambient Temperature
			40 °C (104 °F)			20 °C (68 °F)			0 °C (32 °F)			Battery Compartment Temperature
Channel Banks	Load, Amperes	Battery Sets	1	3	5	1	3	5	1	3	5	Battery Age, Years
1	2.8	1	6.4	5.0	3.6	5.8	4.5	3.2	4.8	3.8	2.7	Hours
		2	12.8	10.0	7.2	11.6	9.0	6.4	9.6	7.6	5.3	
		3	19.3	15.0	11.7	17.4	13.5	9.6	14.4	11.2	8.0	
2	4.8	1	3.7	2.9	2.1	3.4	2.6	1.9	2.8	2.2	1.6	
		2	7.4	5.8	4.2	6.7	5.2	3.8	5.6	4.4	3.1	
		3	11.2	8.7	6.4	10.1	7.9	5.6	8.4	6.6	4.7	

Notes:

1. Data in this table is based on a one-set battery capacity of 20 Ah at 40°C (104° F), 18 Ah at 20°C (68°F), and 15 Ah at (0°C) 32°F.
2. Housing is sealed.

Figure 5-5. Available Hours of Standby Battery Operation (Typical) Based on Load, Temperature, and Battery Age With 9002B Channel Banks

				38 °C (100 °F)			18 °C (64 °F)			0 °C to —40 °C (32 ° to —40 °F)			Outside Ambient Temp
				40 °C (104 °F)			20 °C (68 °F)			0 °C (32 °F) [4]			Battery Compartment Temp
Channel Banks	Load, Amperes	Battery Type	Battery Sets	1	3	5	1	3	5	1	3	5	Battery Age, Years
1 ea	2.2	A [1]	1	8.2	6.4	4.5	7.4	5.8	4.0	6.1	4.8	3.4	Hours
			2	16.4	12.8	9.0	14.8	11.6	8.0	12.2	9.6	6.8	
			3	24.6	19.2	13.5	22.2	17.4	12.0	18.3	14.4	10.2	
		B [2]	1	24.6	19.2	13.5	22.2	17.4	12.0	18.3	14.4	10.2	
		C [3]	1	32.8	25.6	18.0	29.6	23.2	16.0	24.4	19.2	13.6	
2 ea	3.6	A [1]	1	5.0	3.9	2.7	4.5	3.5	2.5	3.8	2.9	2.0	Hours
			2	10.0	7.8	5.4	9.0	7.0	5.0	7.6	5.8	4.0	
			3	15.0	11.7	8.1	13.5	10.5	7.5	11.4	8.7	6.0	
		B [2]	1	15.0	11.7	8.1	13.5	10.5	7.5	11.4	8.7	6.0	
		C [3]	1	20.0	15.6	10.8	18.0	14.0	10.0	15.2	11.6	8.0	

Notes:

[1] Data on battery type A is based on one, two, or three sets of gelled electrolyte type batteries with capacity of 20 Ah at 40°C (104°F), 18 Ah at 20°C (68°F), and 15 Ah at 0°C (32°F).

[2] Data on battery type B is based on one set of four maintenance free automotive type batteries (size No. 72) with approximate capacity of 60 Ah at 40 °C (104 °F), 54 Ah at 20 °C (68 °F), and 45 Ah at 0 °C (32 °F).

[3] Data on battery type C is based on one set of four maintenance free automotive type batteries (size No. 74) with approximate capacity of 80 Ah at 40 °C (104 °F), 72 Ah at 20 °C (68 °F), and 60 Ah at 0 °C (32 °F).

[4] Housing is sealed.

91271 unit also has a low-voltage alarm output that is compatible with the auxiliary alarm circuits to the central office.

5.18 Customer-Furnished Power Plant. A customer-furnished power plant at a remote office should have a low-voltage monitor with normally closed alarm relay contacts for controlling auxiliary alarm circuits to the central office. A 91155 Fuse and Alarm Shelf can be used for dc power distribution. Because channel units supply talk battery to subscriber loops, noise from a customer-furnished power plant should not exceed 30 dBrnC.

5.19 Equipment Protectors. All subscriber pairs require protection. Dual 470-volt gas tube protectors are furnished with the 910A housing assembly; also they are recommended for office installations although standard carbon block protectors are acceptable. Because square-wave ringing from subscriber channel units may have a peak amplitude of 320 volts to ground, gas tubes rated at 350 volts nominal should not be used.

5.20 In the 25-pair cable between the vf line protector block and each channel bank (figure 10-7D), a violet-slate pair from protector 25 or 50 is tied back at channel unit 24. This wiring can be utilized for one four-wire channel unit in each channel bank. For additional four-wire channel units, mount another block above the existing block (figure 8-6) and wire it to the channel bank as required. Order one protector block (GTE Lenkurt stock no. 149-54190-01) and one bracket (020-54201-01).

5.21 Protectors with heat coils should be used in remote terminal office installations. The protector block in the 910A housing assembly has a heat coil alarm bus, but heat coils are not recommended because they may trip at high ambient temperatures possible in the housing. This could result in a runaway thermal condition: when tripped the heat coil shorts the pair, creating additional power dissipation and heat. Overheat thermostat S6 will shut off the terminals if this occurs. The protector overheat thermostat S6 has been removed on the 55910 Model 2 housing and the S6 wiring is jumpered between 91271 unit J1, pins 4 and 18.

5.22 +48V Power Supply. If the 91266 channel unit is equipped with code A, when an operator comes on the line, the channel unit disables the paystation TCMF pad by switching the ring side of the loop from −48V to +48V. The positive voltage may be obtained from a Lorain T8T Power Converter (described in figure 6-1) or another equipment supplying +50V at 0.25A minimum and meeting talk battery requirements. Mount the power converter on rack 1, leaving open space below the chargers for ventilation. Figure 10-7G shows existing wiring to be used for −48V input and distribution of +48V to channel unit pin 37.

5.23 20-Hz Ringing Generator (Battery Connected). If the channel bank is equipped with one or more foreign-exchange subscriber channel units (91259 FXS), a Warren Model 1CRR15 20-Hz Ringing Generator (figure 6-1) or equivalent is required. Mount the generator on rack 1, leaving open space below the chargers for ventilation. Figures 10-7G and H shows existing wiring to be used for −48V input and 20-Hz output. The 20-Hz output from the Warren 1CRR15 must be battery connected. To accomplish this, connect another lead from the blue lead connection to one side of the transformer. Connect the yellow lead to the other side of the transformer and ground the gray lead.

Central Office Terminal

5.24 Equipment Location. The pcm equipment must be separated from relay and step switching equipment by at least one rack width. Electrical radiation and noise spikes from switching equipment can cause erratic operation of the pcm equipment.

5.25 If the central office is already equipped with pcm carrier equipment, space for the hf line terminating equipment may be available in the trunk carrier equipment bays. If no pcm trunk carrier is planned, then the hf line terminating equipment can be mounted on the same racks as the channel banks. See figure 6-7.

5.26 Jacks. Usually, the carrier terminals will be cabled to the horizontal side of the MDF and then assigned to the office vf equipment by jumpers. External jackfields are not required; central-office channel units have a normalled-through vf jack for testing the carrier and pin jacks for testing toward the office.

5.27 Auxiliary Alarm Panel. Auxiliary alarm (AA-) leads from the channel bank to the 91275 panel can be unshielded 22-gauge (0.63 mm) wire. To assure adequate noise immunity, the difference in ground potential between the channel unit and the 91275 panel should not exceed 0.25 volt. Normally, this requirement will be met by obtaining power ground for the 91275 panel from the channel bank.

5.28 A short cable assembly that includes receptacle J1 and terminal board TB1 is furnished with the 91275 panel. See figure 5-7. The receptacle plugs into a mating connector on the panel and TB1 mounts on the back of the rack. External connections are made to wirewrap terminals on TB1.

Channel Units

5.29 Number Equipped. Preferably, the channel banks should be fully equipped and all channels maintained as though assigned for service. Operation with fewer than two channel units in the upper level of the shelf and two in the lower level is not recommended because of a possible increase in idle channel noise when the channel bank common equipment is lightly loaded.

5.30 Channels 1 through 6 of either channel bank must be equipped with subscriber or paystation channel units (except 91266/91267) to provide the auxiliary alarm transmission facility. Foreign-exchange, dial pulse, and E&M channel units can not be used here.

5.31 C-Lead Application. The office channel units basically require a two-wire appearance on the horizontal side of the MDF. During a system alarm, the carrier presents an open loop to the CO equipment and, therefore, a ring but no answer on calls from the central office. During functional testing with the 91276 Pulsing/VF Test Adapter, the loop is closed and pulsing and transmission can be verified.

5.32 An optional C-lead connection is available for special applications but requires cabling for a non-standard three-wire appearance on the horizontal side of the line IDF. With this connection, unplugging a channel unit grounds the C-lead. Also, when the NORM/TEST switch on the channel unit is placed in TEST, the C-lead is grounded and the office line equipment is seized simultaneously. The C-lead ground also prevents normal access to the CO equipment for functional testing with the 91276 test adapter.

Repeatered Line

5.33 Spare Line Switching. Automatic span line switching equipment is recommended although it is not mandatory. The 910A housing assembly is wired for the 91133 1-for-2 Switching Logic Unit, which provides automatic transfer between one spare span line and two working span lines (in each direction of transmission). An office installation may use the 91133 unit or the 91120 Spare Line Transfer Shelf, which has 1-for-n switching capability; refer to Section 342-910-114 (91A Spare Line Transfer).

5.34 A spare line can be shared by more than one housing along the same cable route. Modification of the 910A housing assembly at an intermediate or remote location for this application is shown in figures 10-9 and 10-10. Consult your GTE Lenkurt sales engineer for additional equipment requirements and span power considerations.

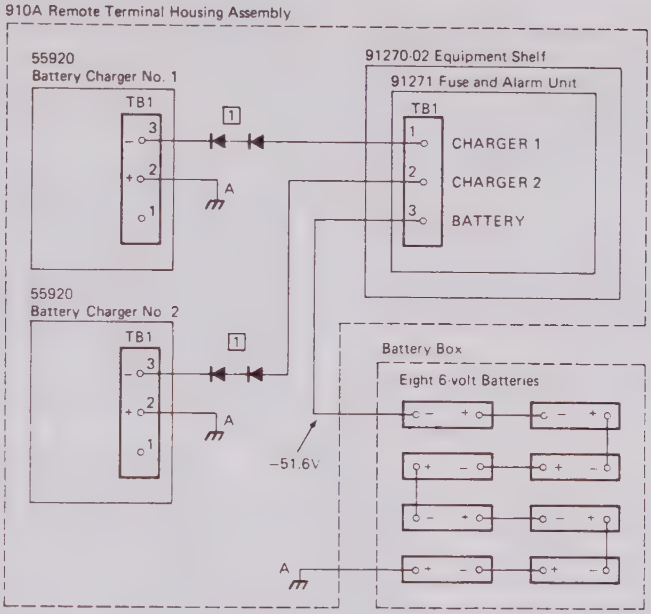
5.35 Spare Line Driver. At a remote terminal, instead of simply looping receive to transmit, the spare line may have to be driven by a 91113 Bridging Repeater Unit; see paragraph 5.38. At the CO terminal, the spare line can be driven by a 91108 PCM Signal Power Divider; the 91113 unit is mainly used for trunk carrier where in-service patching may be necessary.

5.36 Remote Fault Locating. Fault locating the span lines in both directions from the central office requires spare line switching to provide a pcm loop and repeater housings equipped with 91115-xx Fault Locating Filter Units. The dc ▶amplifiers in the 91115-03 filter units function as remotely controlled switches, enabling the central office to monitor repeater side 1 and side 2 independently. (The 91111-01 Line Repeater Units must be strapped for separate fault locating outputs from side 1 and side 2.) The 91115-xx filter units can be installed in these types of housings: 91087, 91088, 91089 Model ▶2, 91170, 91171, and 91173. Also refer to Section 342-910-106 for additional housings.◀

▶5.37 Model 1 of the 91089 housing can be modified to use the -03 filter unit by adding a multiple connection from the filter unit to pin 3 at each repeater unit mounting position. This new circuit will be for monitoring repeater side 1. Side 2 will be monitored on the existing multiple connection to pin 6.◀

5.38 If side 1 and side 2 of the line repeaters cannot be monitored independently, remote fault locating cannot be used because the audio signals derived from the "go"

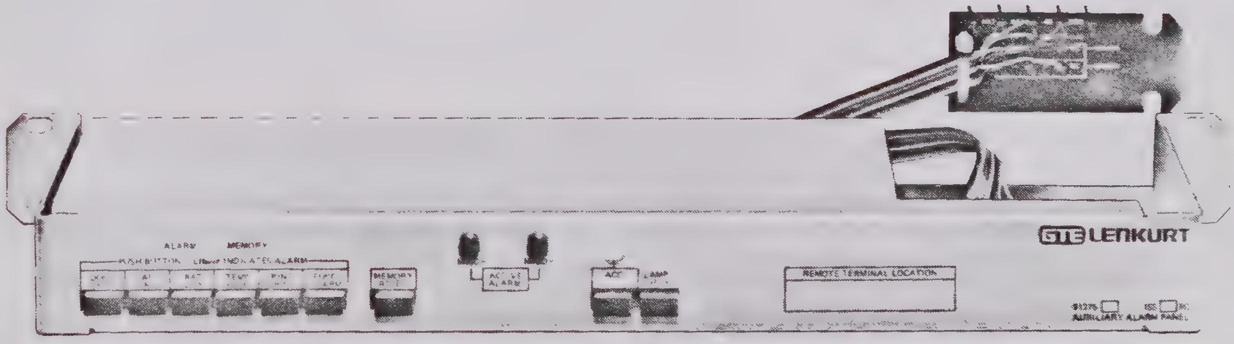
Figure 5-6. Modification of Charger Circuit For External Battery


910A Remote Terminal Housing Assembly
55920
Battery Charger No. 1
TB1
3
2
1
−
+
1
A
91270-02 Equipment Shelf
91271 Fuse and Alarm Unit
TB1
1
2
3
CHARGER 1
CHARGER 2
BATTERY
55920
Battery Charger No 2
TB1
3
2
1
−
+
1
A
−51.6V
Battery Box
Eight 6-volt Batteries
A

Notes.

1 Customer-furnished diodes, silicon power-type with minimum rating of 10 amperes and 100 peak inverse volts

Figure 5-7. 91275 Auxiliary Alarm Panel


GTE LENKURT
ALARM
MEMORY
REMOTE TERMINAL LOCATION
AUXILIARY ALARM PANEL

and "return" hf signal interfere. Consequently, the spare line must be driven instead of looped back at the remote terminal. If the remote terminal is in a 910A housing assembly, a 91113 Bridging Repeater Unit is installed in position J8 of the 91101 shelf with shelf wiring modified as shown in figure 10-8. The 91108 PCM Signal Power Divider could be used, but another hf pair would have to be run between rack 1 and rack 2.

5.39 End Section Loss. The maximum allowable cable loss in end sections of the repeatered line will be reduced by loss in the 3-dB pad or recommended 7.5-dB equalizer of the 91112 Office Terminating Repeater Unit. An additional restriction on end section loss because of central office switching noise (Section 836-910-072 for 9101C and 836-910-081 for 9104A) will not normally be applicable to the end section at the remote terminal.

5.40 Span Power. The 910A housing assembly is factory wired for use with bidirectional line repeaters and one-cable (or screen cable) operation. For other applications, span power jumpers on the 91101 shelf must be rearranged. See Section 342-910-103 or 342-910-105. Two-cable operation is limited to two repeatered lines because three lines cannot be powered.

5.41 Although span power (48, 130, 180, or 260 volts) can be applied at the 910A housing assembly, as many line repeaters as possible should be fed from the central office terminal. This will minimize the number of power supplies and batteries at the remote terminal and reduce the temperature rise inside the housing.

▶ 5.42 The 91105 Simplex Power Unit controls the simplex power feed to the span lines. The unit contains strappable resistors for setting loop current from the office ±130 Vdc power supplies.

5.43 A 91125 Simplex Power coverter unit may be used instead of the 91105 unit. The 91125-01 unit provides a regulated 60mA dc power supply at up to ±130 Vdc for the simplexed line current which feeds the span line. The 91125-02 is the same as the -01, execpt it provides 60mA, 100mA, or 120mA output as strapping options. Use of the 91125 unit offers the following advantages.

(a) Eliminates need for redundant ±130 Vdc office mounted span power supplies.

(b) Provides independent regulated source of power fo each span line.

(c) Simplifies engineering of span power requirements.

(d) Produces less heat than the 91105 (more efficent dc-dc conversion).◀

5.44 For exceptionally long span lines, a 310-volt supply for line repeater power can be set up in the 910A housing assembly by substituting the 180V output of 91272 Power Supply Unit for the 130V output. (The substitution cannot be made in an office installation where the voltage is distributed through a 91103 Fuse and Alarm Unit.) Necessary modification of the 91270 shelf wiring is shown in figure 10-11. With any output configuration, the continuous load on a 91272 unit (excluding the −48V output component) must not exceed 78 watts.

5.45 In an office installation, for higher current capacity or for redundant operation, corresponding outputs from two or three 91272 units may be connected in parallel. This application is described in Section 342-910-103 or 342-910-105. The third 91272 unit is installed in the shelf mounting position of the 91271 Fuse and Alarm Unit; hence, functions of the 91271 unit must be provided by other equipment, such as the 91155 Fuse and Alarm Shelf.

5.46 Order Wire. For order wire service at repeater housings and the remote terminal, a loaded pair in the span cable can be connected to a central office linefinder, directly or through a 55090 Order Wire Shelf (Section 342-910-103). Maximum dc loop resistance of the pair is 1300 ohms. Longer spans can be sectionalized, with order wire service to the remote section via an unassigned 910A carrier channel terminated in another linefinder at the central office.

5.47 The 910A housing assembly includes an order wire jack and a mounting bracket that fits two types of wall telephones:

(a) Automatic Electric type 192A Starlite telephone with rotary dial.

(b) Western Electric telephone (Trimline) with type AC1 base and 220A rotary dial.

The telephone, which is customer-furnished, will be useful for functional channel tests at the remote terminal, as well as on the order wire. Applications of the order wire jack are described in paragraph 3.08.

6. EQUIPMENT IDENTIFICATION

6.01 Figure 6-1 lists the 910A equipment (panels, shelves, and units) in type number order and briefly describes each item, including any applicable dash number variations. Latest model numbers as of the publication date are shown for equipment not covered in other GTEP Sections. For model numbers of channel bank common equipment or repeatered line equipment, refer to Section 342-911-107 (9002B) or 342-910-105/-106 (9104A). See paragraphs 1.02 and 8.04 for additional information on compatibility of model numbers. Equipment quantities for a 48-channel assembly at a central office or a remote location are given in figure 6-2.

6.02 Remote Terminal Housing Assembly. The basic housing assembly (91910-03 or -04) includes the fiberglass housing and base (plastic on Model 1), a two-rack frame, and the equipment shelves. The assembly is completely wired and equipped as described in the first part of figure 6-2. Additional equipment in figure 6-2 is required but ordered separately, including channel bank common equipment, channel units, and line terminating equipment. Batteries, some power equipment and line terminating equipment are optional.

6.03 Replaceable parts in the 55910 Remote Terminal Housing are listed in figure 6-3.

6.04 Rack-mounted equipment and plug-in units of the housing assembly are called out on figure 6-6. Other items appear in figures 8-7 and 8-9.

6.05 Office Installation. Figure 6-2 also identifies the equipment for an office installation of a CO or remote terminal. Typical configurations of rack-mounted terminals are in figure 6-7.

6.06 Spare Parts. Recommended spare parts, including plug-in units, are listed in figure 6-4.

6.07 Test Equipment. Recommended test equipment is listed in figure 6-5. Equivalent test equipment can be substituted for recommended test equipment.

7. ORDERING INFORMATION

▶7.01 Equipment listed in figures 6-1 through 6-5 may be ordered by specifying the identifying number and name (or brief description).◀

7.02 Upon receiving the order, GTE Lenkurt will provide an acknowledgement and scheduled shipping date. An equipment list showing assemblies and individual equipment items will be included in the shipment.

(Text continues on page 43.)

Figure 6-1. Equipment Used in the 910A PCM Subscriber Carrier System (Sheet 1 of 2)

Type No.	Name	Description and Options	Used On
55920-XX (Model 1)	Battery Charger	Supplies 4 amperes at —53 Vdc (nominal) to remote terminal equipment and batteries (if used). -01 Ac power input: 117V at 60 Hz -02 Ac power input: 220V at 50 Hz	
91101-01	Line Terminating Shelf	Mounting facility for various span line terminating equipment.	
91103-01	Fuse and Alarm Unit	Distributes power to units of the 91101 shelf.	91101
91105-01	Simplex Power Unit	Contains strappable resistors for setting loop current from office ±130 Vdc power supplies. (The 91125 unit is preferred.)	
91108-01	PCM Signal Power Divider	Divides a pcm signal into two paths with a 6-dB loss in each path.	
91112-XX	Office Terminating Repeater Unit	Provides interface between span lines and terminal equipment. -01 With 3-dB pads -02 Same as -01 with error detector -04 With 7.5-dB equalizers and error detector (Recommended)	91101
91113-01	Bridging Repeater Unit	Energizes spare line with pcm signal obtained from a working system.	
91114-XX	Office Fault Locating Filter Unit	Provides interface between test equipment, repeaters, and fault locating pairs. -01 With amplifier (Manufacture discontinued) -02 Without amplifier -03 With Amplifiers. Provides +117 Vdc regulated supply for Bell Outstate application." Code A 832-Hz bandpass filter B 928-Hz C 1048-Hz D 1206-Hz E 1340-Hz F 1508-Hz G 1722-Hz H 2008-Hz J 2193-Hz K 2413-Hz L 2680-Hz M 3017-Hz bandpass filter	
91125-XX	Simplex Power Converter Unit	Used in lieu of 91105 units to eliminate need for redundant ±130 Vdc office mounted span power supplies. (See para. 5.43) -01 For regulated 60 mA repeatered line simplex current -02 Same as -01 except has strapping options for 60 mA, 100 mA, or 120 mA operation.	
91133-01	1-For-2 Switching Logic Unit	Switches one of two working systems to a spare set of span lines.	
91155-01	Fuse and Alarm Shelf	Mounting facility for six fuse assemblies (Code A) and one relay assembly. Code A One fuse assembly; distributes —48V, —130V, or +130V through eight alarm-type fuses.	
91330-XX	Terminal Equipment Shelf	Holds common equipment and channel units for a 24-channel 9002B PCM Channel Bank -01 Installer connections to 2-wire vf and C-lead (if used) made at wirewrap terminals on channel unit shelf receptacles J1-J12 and J17-J28. -02 Installer connections made at 50-pin male connectors J33 (2-wire vf) and J31 (C-lead, if used) using 25-pair Cable Assembly 163-10315-XX or 163-10316-XX.	Channel bank
91221-01	Transmit Common Equipment Unit	In the transmit direction, converts vf and signaling information on 24 channels into a 1.544-Mb/s bipolar PCM signal.	
91222-01	Receive Common Equipment Unit	In the receive direction, processes the incoming 1.544 Mb/s bipolar pcm signal to recover vf and signaling information for 24 channels.	
91230-01	Alarm and Control Unit	Monitors dc power, receive synchronization, and integrity of incoming signal. Includes circuitry for loopback testing and simultaneous restoral.	
91235-02	Power Supply Unit	From a —48V input, derives five regulated dc voltages for use by units of the 91330 shelf.	
91260-01 (Model 2)	Bridged Ringing Subscriber Channel Unit	At a remote terminal, the 91260 unit provides subscriber line service with four-party frequency-selective bridged ringing and ONI (operator number identification).	
91261-01 (Model 1)	Bridged Ringing Office Channel Unit	The 91261 channel unit operates at a CO terminal with the 91260 channel unit at a remote terminal.	
91262-01 (Model 2)	Divided Ringing Subscriber Channel Unit	At a remote terminal, the 91262 channel unit provides subscriber line service with two-party frequency-selective divided (or bridged) ringing and ANI (automatic number identification).	
91263-01 (Model 1)	Divided Ringing Office Channel Unit	The 91263 channel unit operates at a CO terminal with the 91262 channel unit at a remote terminal.	
91264-01 (Model 1)	Superimposed Ringing Subscriber Channel Unit	At a remote terminal, the 91264 channel unit provides four-party full-selective ringing or up to eight-party semi-selective ringing at stations equipped with a three- or four-element gas tube and straight line ringer.	
91265-01 (Model 1)	Superimposed Ringing Office Channel Unit	The 91265 channel unit operates at a CO terminal with the 91264 channel unit at a remote terminal.	
91266-XX (Model 1)	Full-Prepay Subscriber Channel Unit	At a remote terminal the 91266 channel unit provides pay-station line service with bridged ringing, ±130 Vdc coin control, and the following: -01 Coin-first operation or coin-free emergency, directory, and operator type service with offices so designed or modified. The unit is for use with GTE AE offices and stromberg-Carlson XY offices. A GTE AE No. 1 EAX office must be	

Figure 6-1. Equipment Used in the 910A PCM Subscriber Carrier System (Sheet 2 of 2)

Type No.	Name	Description and Options	Used On
		equipped with FB-10156-01 coin office junctors. -03 Same as -01 except designed for use with Western Electric offices where tip side of paystation loop must be open during idle or nonbusy conditions. Code A Plug-in subassembly 087-55378-01 for 91266-01, or -03 channel unit; permits central office to disable TCMF pad by application of +48V to ring side of two-wire drop; subscriber-end units equipped with code A require +48V (between pin 37 and ground) from an external dc supply such as a Lorain T8T Power Converter.	
91267-01 (Model 1)	Full-Prepay Office Channel Unit	The 91267 channel unit operates at a CO terminal with a 91266 channel unit at a remote terminal.	Channel bank
91268-01 (Model 1)	Semi-Postpay Subscriber Channel Unit	At a remote terminal, the 91268 channel unit provides paystation or regular single-party subscriber line service with bridged ringing and reverse battery supervision. The units can also be used for hote/motel lines requiring message metering.	
91269-01 (Model 1)	Semi-Postpay Office Channel Unit	The 91269 channel unit operates at a CO terminal with a 91268 channel unit at a remote terminal.	
91270-XX (Model 1)	Equipment Shelf	-01 Holds one 91271 unit and one or two 91272 units or three 91272 units. -02 Holds one 91271 unit and one or two 91272 units; includes diodes CR1 and CR2; used in 910A housing assembly.	
91271-01 (Model 1)	Fuse and Alarm Unit	Distributes —48 Vdc to remote terminal equipment; interconnects chargers and battery; gives blown fuse and low voltage alarms.	91270
91272-XX (Model 1)	Power Supply Unit	-01 From —48 Vdc input, generates output voltages of 79 Vdc, 130 Vdc, and 180 Vdc that may be used for subscriber ringing, pay station coin control, or span power. Failure alarm on 79 Vdc output circuit. Used in stand-alone (non-redundant) applications. -02 Same as -01 except has "power on" indicator, and failure alarm for all dc output circuits. Used in redundant power supply applications.	
91275-01 (Model 2)	Auxiliary Alarm Panel	At a CO terminal, receives and stores six alarm indications from a remote terminal.	
	Rechargeable battery, stock no. 149-54139-01	12-volt, 20 ampere-hour lead-acid battery with gelled electrolyte; used in a 910A housing assembly in sets of four for standby power.	
	T8T Power Converter (Lorain)	Converts —48V input to plus and minus 35, 40, 45, or 50V outputs (strap option); 3A input fuse; 0.75A maximum output; 15 dBrnc maximum noise on output; output failure alarm contacts and indicator lamp; two mounting spaces. Used only with 91266 FPS channel units equipped with code A.	
	1CRR15 20-Hz Ringing Generator (Warren)	From a —48V input, generates a 20-Hz sine wave ringing supply of 15 VA with voltage adjustable between 80V and 160V; short-circuit protected; alarm-type indicating fuse; two mounting spaces. Used only with foreign-exchange subscriber channel units (91259 FXS).	

Figure 6-2. List of Equipment For a 48-Channel Assembly (Sheet 1 of 2)

Equipment	Quantity Required		
	Central Office	Remote	
		Office	Housing
REMOTE TERMINAL HOUSING ASSEMBLY [9]			
91910-03 (117 Vac) or -04 (220 Vac) Remote Terminal Housing Assembly consisting of one each of the following, unless otherwise specified:			1
55910-03 (117 Vac) or -04 (220 Vac) Remote Terminal Housing, factory-wired and equipped with: 91330-01 Terminal Equipment Shelf (quantity of two) 91270-02 Equipment Shelf 91101-01 Line Terminating Shelf Ac power distribution facilities Ventilation fan and thermostats Vf line protector block with 50 protector modules Hf line protector block with nine arresters (350V)			
55920-01 (117 Vac) or -02 (220 Vac) Battery Charger (quantity of two) 91271-01 Fuse and Alarm Unit (position J1) 91272-01 Power Supply Unit (ringing/coin control, position J2)			
CHANNEL BANK COMMON EQUIPMENT [1]			
91300-01 or -04 PCM Channel Bank Assembly consisting of one each of the following:	2	2	
91330-01 or -02 Terminal Equipment Shelf 91221-01 Transmit Common Equipment Unit 91222-01 Receive Common Equipment Unit 91230-01 Alarm and Control Unit 91235-02 Power Supply Unit			
91300-02 PCM Channel Bank Common Equipment consisting of one each of the following:			2
91221-01 Transmit Common Equipment Unit 91222-01 Receive Common Equipment Unit 91230-01 Alarm and Control Unit 91235-02 Power Supply Unit			
CHANNEL UNITS [2]			
91260-01 Bridged Ringing Subscriber Channel Unit		48	48
91261-01 Bridged Ringing Office Channel Unit	48		
91262-01 Divided Ringing Subscriber Channel Unit		48	48
91263-01 Divided Ringing Office Channel Unit	48		
91264-01 Superimposed Ringing Subscriber Channel Unit		48	48
91265-01 Superimposed Ringing Office Channel Unit	48		
91266-XX Full-Prepay Subscriber Channel Unit		48	48
91267-01 Full-Prepay Office Channel Unit	48		
91268-01 Semi-Postpay Subscriber Channel Unit		48	48
91269-01 Semi-Postpay Office Channel Unit	48		
POWER AND ALARM EQUIPMENT			
55920-01 or -02 Battery Charger		2 [6]	2 [3]
91155 Fuse and Alarm Shelf	1	1 [6]	
91270-01 Equipment Shelf	1 [5]		
91270-02 Equipment Shelf ▶		1	
91271-01 Fuse and Alarm Unit (position J1)		1 [6]	1 [3]
91272-XX Power Supply Unit (ringing/coin control, position J2)			1 [3]
91272-XX Power Supply Unit (span power, position J3)			1 [4]
91272-XX Power Supply Unit (span power or ringing/coin control, position J1 or J3)		2 [5]	
91272-XX Power Supply Unit (span power, position J1, J2 or J3)	3 [5]		
Rechargeable battery, 12V, 20 Ah; stock no. 149-54139-01			8 [6]
Bracket for rack mounting two 55920 Battery Chargers; stock no. 020-54165-01		1	
91275 Auxiliary Alarm Panel	1		
T8T Power Converter (Lorain)		1 [10]	1 [10]
1CRR15 20-Hz Ringing Generator (Warren)		1 [11]	1 [11]
LINE TERMINATING EQUIPMENT			
91101-01 Line Terminating Shelf	1	1	1 [3]
91103-01 Fuse and Alarm Unit	1	1	
91105-01 Simplex Power Unit or 91125 Simplex power Converter Unit	3	3 [8]	3 [8]
91108-01 PCM Signal Power Divider	1 [6]		
91112-XX Office Terminating Repeater Unit (-04 recommended)	3 [7]	3 [7]	3 [7] ◀
91113-01 Bridging Repeater Unit		1 [6]	1 [6]
91114-XX Office Fault Locating Filter Unit	1 [7]	1 [7]	1 [7]
91133-01 1-For-2 Switching Logic Unit	1 [6]	1 [6]	1 [6]

Figure 6-2. List of Equipment For a 48-Channel Assembly (Sheet 2 of 2)

Notes:
[1] 91330-01 and -02 shelves are used with 91300-01 and -04, respectively.
[2] Maximum of 48 channel units of types listed or types described in Section 342-911-103 (foreign-exchange, dial pulse, and E&M).
[3] Included as part of 91910-03 or -04 Remote Terminal Housing Assembly.
[4] Required when span power over 48V is fed from remote terminal.
[5] For redundant power supply or load sharing, use the 91270-02 Equipment Shelf and 91272-02 Power Supply Units or use the 91125 for independent span power.
[6] Optional. See Part 5.
[7] See figure 6-1 and Section 342-910-105 for applicable options.
[8] Required when span power is fed from remote terminal. Or use 91125 units for independent span power.
[9] Type numbers 91910-03, 55910-03 and 55920-01 pertain to primary ac power of 117V at 60 Hz. Type numbers 91910-04, 55910-04, and 55920-02 pertain to primary ac power of 220V at 50 Hz.
[10] Required when remote terminal includes 91266 channel units equipped with code A.
[11] Required when remote terminal includes foreign-exchange subscriber channel units (91259 FXS).

Figure 6-3. Replaceable Parts in 55910 Remote Terminal Housing

Description	Reference Designation	GTE Lenkurt Stock No.
Battery, rechargeable, 12V (Model 1 housing with 9002B equipment and Model 2 housing)	BT1-BT8	149-54139-01
Battery, rechargeable, 12V (Model 1 housing with 9002A equipment)	BT1-BT12	149-54139-01
Capacitor, 330 Vac, 1.0 μF (used with fan 087-54342-01)	C2	659-43043-01
Capacitor, mylar, 150 Vdc 2.1 μF	C3	056-41210-43
Circuit breaker, 15A, 250 Vac	CB1, CB2	175-54243-01
[1] Circuit breaker, 10A, 240 Vac	CB1	175-55412-01
Circuit breaker, 10A, 117 Vac	CB3	175-54252-01
Battery wiring harness assemblies, Model 2 (see figure 8-10)		140-54102-11
Connector, receptacle; push-on type for battery terminal		140-54102-01
Connector cover, black; for positive battery terminal		140-54102-06
Connector cover, white; for negative battery terminal		
Fan, 117 Vac, 315 cubic feet/minute		087-54342-01 or -02
Fiberglass housing lid, Model 2		122-56617-01
Fiberglass housing base, Model 2		122-56617-02
Fiberglass housing door, Model 2		122-56617-03
Jack, telephone, miniature, ADE PJ-939	J5, J6	139-53845-07
Lightning protector, power line		175-54188-01
Relay, 117 Vac	K1	[2] 185-56670-01
Relay, 117 Vac	K1	[3] 185-11386-01
[1] Relay, 220 Vac	K1	[2] 185-56670-02
[1] Relay, 220 Vac	K1	[3] 185-55408-01
Resistor, wirewound 50W, 500 ohm (part of 220W heater, Model 1 only)		169-43159-04
Resistor, precision, 1/2W, 900 ohm	R3	161-09003-02
Switch, interlock	S4, S5	134-20779-01
Switch, toggle, DPDT (Model 1 only)	S8	134-17151-01
Thermostat (Replacement for Model 1 and 2 housings)	S1	149-54294-04
Thermostat (Model 1 only)	S2, S7	149-54294-02
Thermostat (S6 not provided on Model 2 housings)	S3, S6	149-54294-03
[1] Transformer, power (220V to 110V)	T1	180-55425-01
Vf line protector block		149-54190-01

Notes:
[1] Used when primary power is 220 Vac.
[2] Effective with issue 4 of 55910-M2.
[3] Prior to issue 4 of 55910-M2.

Figure 6-4. Recommended Spare Parts

Description	Ordering No.	Recm Qty	For Each
PCM channel bank equipment consisting of 91330-01 or -02 shelf and one set of common equipment units; for use in maintaining spare units in operating condition ("hot standby")	91300-01 or -04	1	Office
Channel Unit	Applicable type no.	1	1 to 24 units in service
Office Terminating Repeater Unit	91112-01	1	1 to 10 units in service
Office Terminating Repeater Unit	91112-01 or -04	1	1 to 10 units in service
1-For-2 Switching Logic Unit	91133-01	1	1 to 10 units in service
Power Supply Unit	91272-01	1	1 to 10 units in service
Air filter	126-23846-04	4	910A housing assembly
Spare fuse and lamp kit containing 10 of each of the following:	91910-30	1	1 or 2 systems in service
Fuse, 0.25A, type 70K (vio-wht)	175-14307-04		
Fuse, 1A, type AGC	175-14721-07		
Fuse, 2A, type GMT (orn)	175-28996-03		
Fuse, 5A, type GMT (grn)	175-28996-10		
Fuse, 5A, type 70D (grn)	175-14307-02		
Fuse, 8A, type 70M (wht-red)	175-14307-14		
Fuse, 20A, type AGC	175-14721-42		
Lamp 60V	184-10955-23		
Protector module, dual gas tube, 470V	175-54189-01	*2	910A housing assembly
Arrester, three-element gas tube, 350V	175-54210-01	*1	910A housing assembly

*Spares furnished in protector blocks of 910A housing assembly.

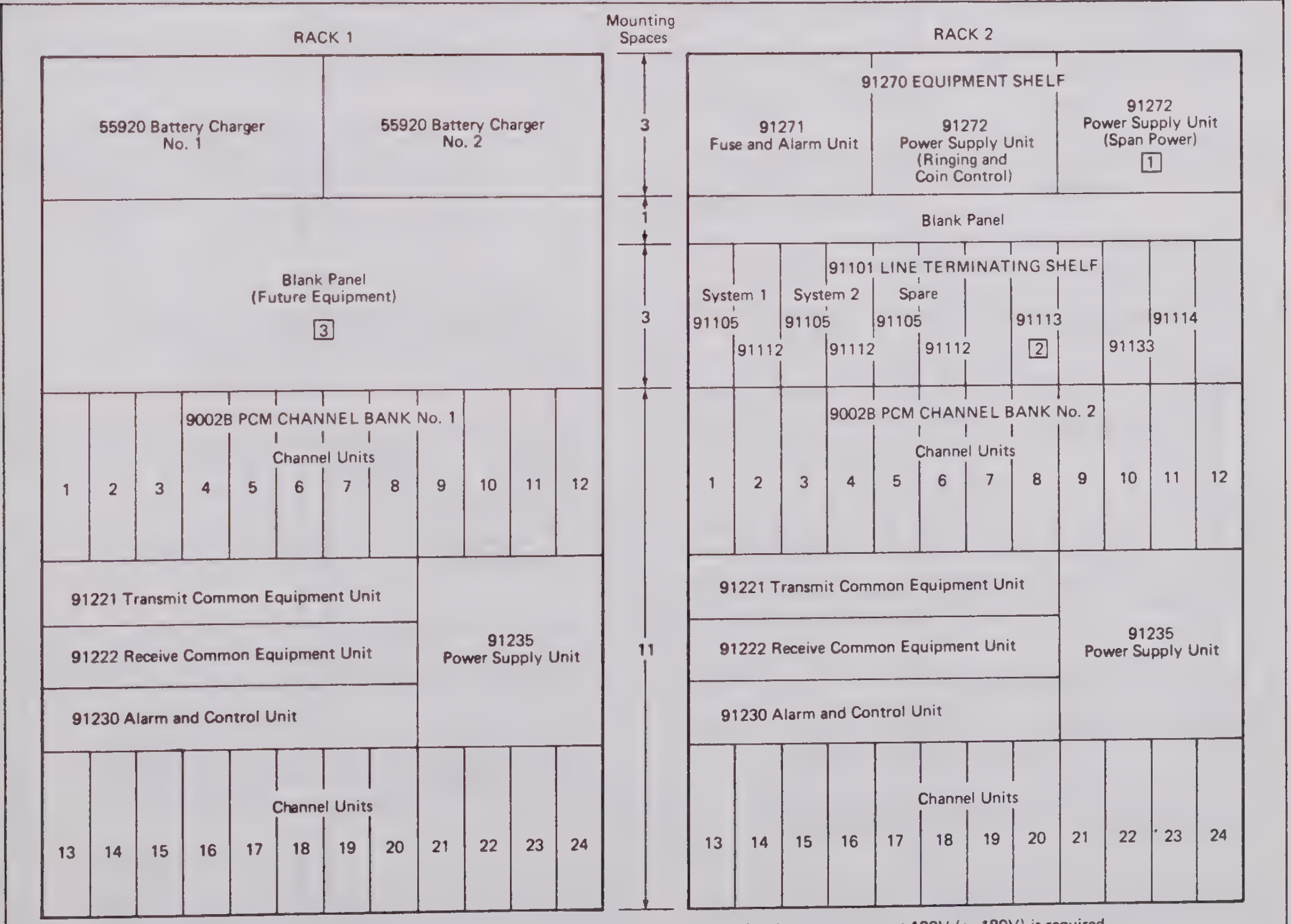
Figure 6-5. Recommended Test Equipment

Qty	Test Equipment Type	Description and Use
1	GTE Lenkurt 91232 Test and Alignment Set (portable)	Provides impedance matching and analog and digital test functions required for test and alignment of pcm channel bank; contains hold coil. Includes required test cords and terminating plugs. (Refer to Section 342-911-103 or -107).
1	Northeast Electronics TTS-37B Noise Measuring Set, or equivalent	Noise and level measuring test set with switch-type weighting networks; contains hold coil. See Note 2.
1	GTE Lenkurt 26600 Signaling Test Set	Used for overall dial pulse signaling distortion tests. (Refer to Section 108-402-504.)
1	H-P 204C Oscillator, or equivalent	Used for looped ringing tests at remote terminal.
1	Simpson 260-6 Multimeter, or equivalent	For measuring dc voltages and setting span line simplex current.
2	GTE Lenkurt 633A Test Cord	TRS plug on each end; 1.8-m (6-foot) shielded cable. Used for PCM line patching tests.
2	GTE Lenkurt 665B Plug	Telephone plug wiht 100-ohm resistor between tip and ring.
1	GTE Lenkurt 725A Test Cord	TRS plug on each end (wired T-S to T-S); 3.7-m (12-foot) low-resistance power cable. For use with 26600 and TTS-37B.
1	GTE Lenkurt 729A Test Cord	TRS plug to twin plug plug; 2.6-m (8-foot) shielded cable. Used with 26600 for looped pulsing tests.
2	GTE Lenkurt 729B Test Cord	Miniature TRS-TT (Tini-Telephone) plug to twin pin plug; 2.6-m (8-foot) shielded cable. Used for remote terminal alignment and order wire.
1	GTE Lenkurt 91276 Pulsing/VF Test Adapter	Connects hand test telephone (butt-in to channel unit and 91230 Alarm and Control Unit on channel bank at CO. Used for remote-looped testing of functional channel operation.
1	GTE Automatic Electric type 800 or 801 Hand Test Telephone (butt-in) or equivalent	Used at CO for remote-looped testing of functional channel operation.
1	Monarch Molding Inc. WTS-620 Coin Box Trunk Test Set, or equivalent	For testing coin control functions of 91266 channel units at a remote terminal.

Notes:

1. Quantities are minimum for each office equipped with 910A systems.
2. For more accurate ac voltage or dB readings, use an H-P 400 EL acvm, or equivalent.
3. Section 032-201-150 gives a complete listing of GTE Lenkurt's standard plugs, adapters, and cords available for patching, testing, or maintenance of the equipment.

Figure 6-6. Rack Layout of 910A Remote Terminal Housing Assembly


RACK 1
Mounting Spaces
RACK 2
55920 Battery Charger No. 1
55920 Battery Charger No. 2
3
1
3
11
91270 EQUIPMENT SHELF
91271 Fuse and Alarm Unit
91272 Power Supply Unit (Ringing and Coin Control)
91272 Power Supply Unit (Span Power) 1
Blank Panel
Blank Panel (Future Equipment) 3
91101 LINE TERMINATING SHELF
System 1
System 2
Spare
91105
91112
91113
2
91114
91133
9002B PCM CHANNEL BANK No. 1
9002B PCM CHANNEL BANK No. 2
Channel Units
1 2 3 4 5 6 7 8 9 10 11 12
91221 Transmit Common Equipment Unit
91222 Receive Common Equipment Unit
91230 Alarm and Control Unit
91235 Power Supply Unit
13 14 15 16 17 18 19 20 21 22 23 24

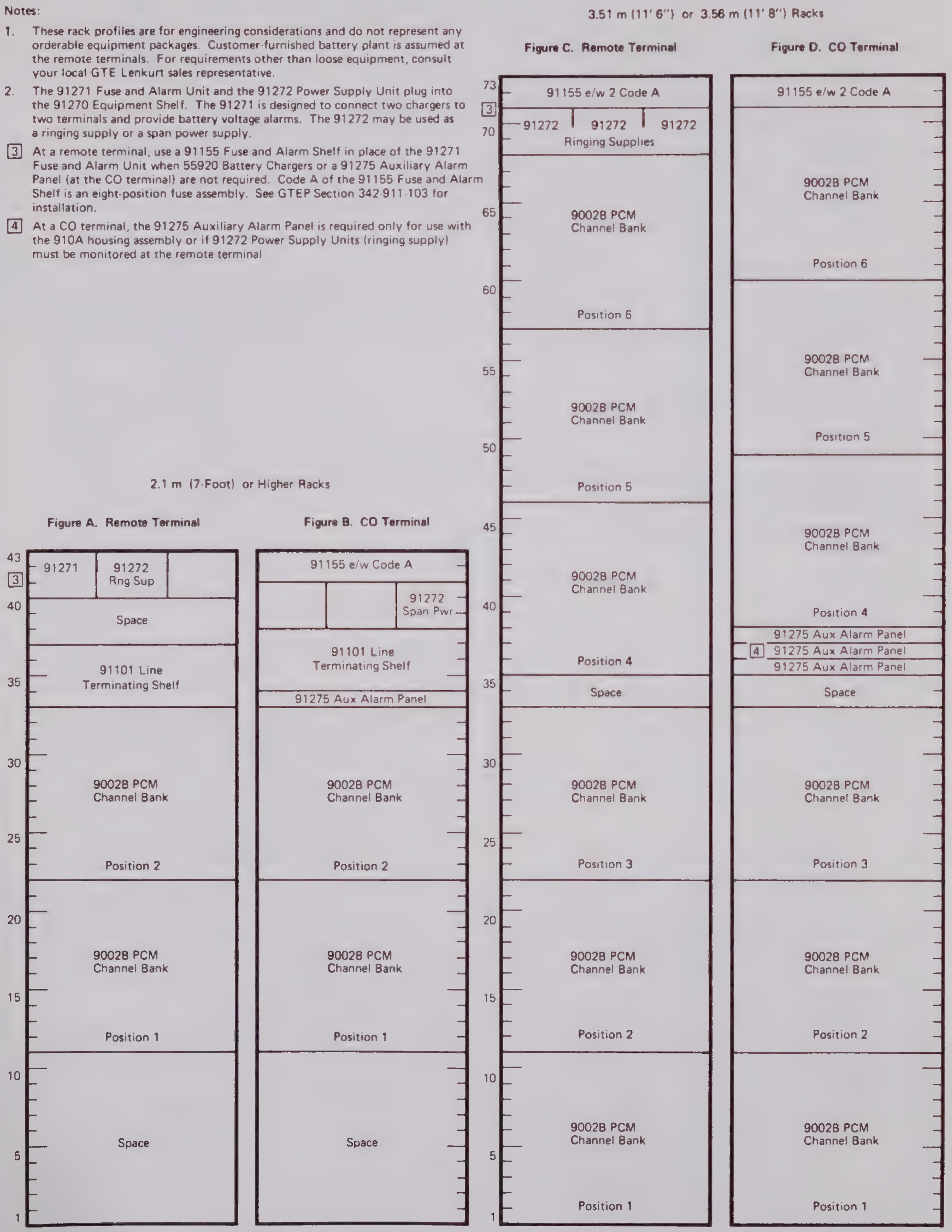
Notes:

1 The second 91272 Power Supply Unit is optional and used only when span power at 130V (or 180V) is required. Not required if 91125 units are used in lieu of 91105 units.

2 The 91113 Bridging Repeater Unit or the 91108 PCM Signal Power Divider (para. 5.38) is required if the spare line is equipped and remote fault locating is not used.

3 When used, the T8T Power Converter (Lorain) or 1CRR15 20-Hz Ringing Generator (Warren) is installed in the lower two of the four vacant mounting spaces on rack 1.

Figure 6-7. Typical Rack-Mounted Terminals


3.51 m (11′ 6″) or 3.56 m (11′ 8″) Racks
Figure C. Remote Terminal
73
3
70
91155 e/w 2 Code A
91272
91272
91272
Ringing Supplies
9002B PCM Channel Bank
Position 6
9002B PCM Channel Bank
Position 5
9002B PCM Channel Bank
Position 4
Space
9002B PCM Channel Bank
Position 3
9002B PCM Channel Bank
Position 2
9002B PCM Channel Bank
Position 1
65
60
55
50
45
40
35
30
25
20
15
10
5
1
Figure D. CO Terminal
91155 e/w 2 Code A
9002B PCM Channel Bank
Position 6
9002B PCM Channel Bank
Position 5
9002B PCM Channel Bank
Position 4
91275 Aux Alarm Panel
4
91275 Aux Alarm Panel
91275 Aux Alarm Panel
Space
9002B PCM Channel Bank
Position 3
9002B PCM Channel Bank
Position 2
9002B PCM Channel Bank
Position 1
2.1 m (7-Foot) or Higher Racks
Figure A. Remote Terminal
43
3
40
35
30
25
20
15
10
5
1
91271
91272 Rng Sup
Space
91101 Line Terminating Shelf
9002B PCM Channel Bank
Position 2
9002B PCM Channel Bank
Position 1
Space
Figure B. CO Terminal
91155 e/w Code A
91272 Span Pwr
91101 Line Terminating Shelf
91275 Aux Alarm Panel
9002B PCM Channel Bank
Position 2
9002B PCM Channel Bank
Position 1
Space

Notes:

1. These rack profiles are for engineering considerations and do not represent any orderable equipment packages. Customer-furnished battery plant is assumed at the remote terminals. For requirements other than loose equipment, consult your local GTE Lenkurt sales representative.
2. The 91271 Fuse and Alarm Unit and the 91272 Power Supply Unit plug into the 91270 Equipment Shelf. The 91271 is designed to connect two chargers to two terminals and provide battery voltage alarms. The 91272 may be used as a ringing supply or a span power supply.

3 At a remote terminal, use a 91155 Fuse and Alarm Shelf in place of the 91271 Fuse and Alarm Unit when 55920 Battery Chargers or a 91275 Auxiliary Alarm Panel (at the CO terminal) are not required. Code A of the 91155 Fuse and Alarm Shelf is an eight-position fuse assembly. See GTEP Section 342-911-103 for installation.

4 At a CO terminal, the 91275 Auxiliary Alarm Panel is required only for use with the 910A housing assembly or if 91272 Power Supply Units (ringing supply) must be monitored at the remote terminal

(Continued from page 36.)

8. INSTALLATION

8.01 Part 8 covers installation of a 910A system and includes a step-by-step procedure for installing a 55910 Remote Terminal Housing. For installation of a CO terminal or for office installation of a remote terminal, also refer to GTEP Sections 342-911-103 and -107 (channel bank) and 342-910-103, -105 and -106 (repeatered line equipment).

Receiving Information

8.02 When the equipment is received, inspect it carefully for damage. Claims for damage incurred in shipment should be reported at once directly to the transportation company in accordance with their instructions. Keep the shipping containers until installation has been completed.

Equipment and Options Required

8.03 Figure 6-6 shows the rack-mounted equipment in a remote terminal housing. Figure 6-7 shows typical rack layouts for office installations. Equipment for a 48-channel terminal is listed in figure 6-1. Equipment received should be checked against the order to insure that it includes the applicable options. Figure 6-2 defines equipment options, which are indicated by dash numbers (or -XX) or by code letters.

8.04 9002A Channel Bank. Addition of certain features to the 9002A channel bank for the 910A system resulted in changes to equipment model numbers and issue numbers. Also, for updating earlier equipment, modification kits (MK) were designed. The 9002A channel bank equipment affected and the earliest usable model/issue numbers are listed below.

(a) 91220 Terminal Equipment Shelf must be Model 2. Model 2 of the shelf has wiring for distribution of coin control voltages, ringing voltage, and frame sync pulses to the 910A channel units.

(b) 91221 Transmit Unit.

(1) If the channel bank is not equipped with 91263 channel units, the 91221 unit may be Model 1 with MK-1 or Model 2. Both provide frame sync pulses required by some 910A channel units.

(2) If the channel bank is equipped with one or more 91263 channel units, the 91221 unit must be Model 2. If the 91221 unit is earlier than issue 6, it also must include modification kit MK-2. In these units, the frame sync pulses are derived from Sig B instead of Sig A.

(c) The 91222 Receive Common Equipment Unit must be Model 2. With the Model 2 unit, channels are forced on-hook during reframing or system alarm.

(d) The 91230 Carrier Group Alarm and Control Unit must be Model 1 with modification kit MK-1 or Model 2. The simultaneous restoral process in these units utilizes bit 2 of the encoded voice signal.

Installer Wiring

8.05 Office Installation. Because of the many possible configurations of a CO terminal or a remote terminal installed in an office, detailed wiring instructions are not appropriate. Refer to GTEP Sections 342-911-103 and -107 (channel bank) and 342-910-103, 105 and -106 (repeatered line equipment), and the following:

(a) 91275 Auxiliary Alarm Panel: figure 10-3.
(b) Channel units: figure 10-4.
(c) 91270 Equipment Shelf (if used): figure 10-5.

8.06 In addition to the above, for a remote terminal office installation figure 10-6 shows external and intrashelf wiring of major signal and power circuits. This is a typical terminal with two channel banks and spare line switching.

8.07 Remote Terminal Housing. The housing is factory wired and requires only connections to the span cable, subscriber loops, and ac service. Instructions are included in the installation procedures, paragraph 8.23.

910A Strapping

8.08 At each terminal, before plugging units into the equipment shelves, install or verify strapping described in following paragraphs.

NOTE: Some wire straps are mobile; one end is anchored and the other end is free to be plugged into a selected optional terminal. If desired, a mobile-type strap can be soldered after connection to the applicable terminal.

Straps on some late model units are a screw type. The circuit through the strap is closed by tightening the screw (do not overtighten) and opened by loosening the screw two full turns.

8.09 91220 or 91330 Terminal Equipment Shelf. On terminal board TB2, strap 2 to 3 to complete the Fr Sync pulse distribution circuit. Do not strap 1 to 3.

8.10 91221 Transmit Common Equipment Unit. Strap the 91221 unit of the 9002A or 9002B channel bank as follows.

(a) Model 1 with MK-1 (9002A only): strap D-E, K-L, M-N, S-T, and P-X. Do not strap U, V, and W.

(b) Model 2 (9002A only): strap M-N, S-T, and X-Z. Do not strap R, U, V, W, and Y.

(c) Model 2 with MK-2 (9002A only): same as Model 2.

(d) Model 2 with MK-6: set subswitches to 910A and INT CLOCK.

(e) Model 3: strap F-H; close screw-strap N; open screw-straps M, R, S, T, and U.

8.11 91222 Receive Common Equipment Unit. Strap the 91222 unit of the 9002A or 9002B channel bank as follows.

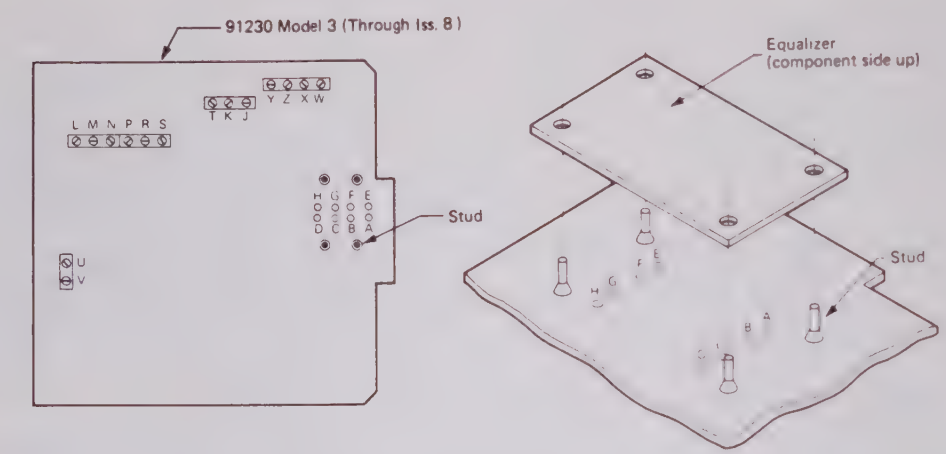
(a) Model 4: close screw-strap A and open screw-strap B.

NOTE: Model 2 and 3 with MK-6: set subswitch for ON-HOOK during frame search or alarm.

8.12 91230 Alarm and Control Unit. See figure 8-1. Strap the 91230 unit of the 9002A or 9002B channel bank as follows.

(a) Model 1 with MK-1 (9002A only): strap S-T, U-V, AA-BB, and 74-84. Do not strap M-N, P-R, V-W, BB-CC, and 25-74.

Figure 8-1. 91230 Unit, Strapping and Equalizer Installation



(b) Model 2 (9002A only): strap L-N, P-J, S-T, U-V, X-Z, and AA-BB. Do not strap DD-EE.

▶(c) Model 3 in 91220 shelf:

(1) Close screw-straps (through Iss. 8) or install strapping plugs (Iss. 9 and later): J, L, N, P, S, and V.

(2) Open screw-straps (through Iss. 8) or remove strapping plugs (Iss. 9 and later): K, M, R, T, U, W, X, Y, and Z.

(d) Model 3 in 91330 shelf:

(1) Close screw-straps (through Iss. 8) or install strapping plugs (Iss. 9 and later): J, L, N, P, S, V, W, X, Y, and Z.

(2) Open screw-staps (through Iss. 8) or remove strapping plugs (Iss. 9 and later): K, M, R, T, and U.◀

8.13 The hf transmit signal path of the channel bank goes through a 6-dB pad on the 91230 unit. If the length of cabling (General Cable type 4162) between the channel bank and the line terminating shelf exceeds 38.1 m (125 feet), one of two equalizers furnished with the equipment is required in place of the pad: 087-53258-01 for cable length between 38.1 m and 114 m (125 and 374 feet); 087-53259-01 for cable length between 114 m and 190 m (374 and 623 feet). For WECo type ABAM cable, the corresponding cable lengths are 45.7 m, 137.2 m and 228.6 m (150, 450, and 750 feet). To install the equalizer:

(a) Cut straps A-B, C-D, E-F, and G-H on unit.

(b) In either orientation, place equalizer over four studs on unit as shown in figure 8-1.

(c) Solder equalizer terminals to studs.

8.14 Channel Units. Strap channel units for the applicable options described on the circuit diagrams listed below.

(a) 91260: figure 4-3
(b) 91262: figure 4-4
(c) 91267: figure 4-13
(d) 91269: figure 4-14

8.15 91101 Line Terminating Shelf. Strap the following plug-in units in accordance with instructions on the unit circuit diagrams in GTEP Section 342-910-105.

(a) 91105 Simplex Power Unit or 91125 Simplex Power Converter Unit
(b) 91112 Office Terminating Repeater Unit
(c) 91114 Office Fault Locating Filter Unit
(d) 91133 1-for-2 Switching Logic Unit

8.16 91275 Auxiliary Alarm Panel. For a CO terminal installation, refer to the notes on figure 3-1 for strapping instructions.

8.17 91270 Equipment Shelf. Refer to notes on figure 10-5 for an office installation of the 91270 shelf or figure 10-7 for installation in a 910A housing assembly. Strapping of the 91272 Power Supply Unit is described on figure 3-3.

Paystation Strapping

8.18 Figure 8-2 provides special strapping information for GTE Automatic Electric paystations when the 91266-01 channel unit is used.

▶Figure 8-2. Special Strapping for GTE Automatic Electric Paystations when 91266-01 Channel Unit is used

Type of Paystation	Paystation Strapping
GTE Automatic Electric Type 120A Single-Slot Coin Telephone Set. Refer To GTEP 476-201-100 table covering strapping options and connections.	Prepay (Must deposit to dial): May use either central office options.
	Emergency Prepay (No desposit required to dial): Use central office option for detecting coin ground by current unbalance in tip and ring.
GTE Automatic Electric Type 120B Single-Slot Coin Telephone Set. Refer to GTEP 476-201-101 table covering service strapping and connections.	In "Ground Isolation" column, strap Q to pin N.
GTE Automatic Electric three-slot paystation, conventional or totalizer equipped.	No special strapping required.

◀

Installation of 910A Housing Assembly

8.19 The 910A housing assembly is shipped from the factory mounted on a wooden pallet. Chargers, plug-in units, and batteries are shipped in separate containers.

8.20 Platform or Pad. The platform or concrete pad for mounting the housing assembly should be constructed before the equipment is delivered to the site. Figure 8-3 shows a typical pad configuration with locations of foundation bolts, conduits, and ground rod. Figures 8-4 (Model 2) and 8-5 (Model 1) give the outline dimensions of the housing assemblies.

8.21 Tools and Materials. The following tools and materials are required for installation of the 910A housing assembly.

(a) Socket wrench set 13 mm (1/2-inch drive) with universal joint, ratchet handle, 457-mm (18-inch) extension, and 19.1-mm (3/4-inch) hex deep socket.

(b) Adhesive sealant, Dow-Corning 732 RTV, 5-ounce tube (GTE Lenkurt stock no. 108-00004-51), or equivalent.

(c) Flat washer and nut for 1/2-13 bolt; 4 required (if available, washers and nuts from shipping pallet may be used).

(d) Hoist, boom type, capable of lifting 204.1 kg (450 pounds) Model 2 or 158.8 kg (350 pounds) Model 1.

(e) Sling, 76-mm (3-inch) wide (or equivalent), capable of lifting 204.1 kg (450 pounds) Model 2 or 158.8 kg (350 pounds); 2 required.

(f) Rope, 13-mm (1/2-inch) diameter, 6.1 m (20 feet) minimum length.

8.22 Mounting the Housing Assembly. Following is a step-by-step procedure for mounting the housing assembly on a platform or pad. Components of the assembly referred to in the procedure are called out on figure 8-6 and 8-7.

(a) Cut and remove bands that secure housing assembly to pallet.

(b) Lift doors up and remove.

(c) Remove 1/4-20 shipping screw at top of each equipment rack.

(d) Unbolt housing assembly from pallet (four bolts). Rotate equipment racks (paragraph 10.42) as necessary to reach rear bolts. Save the 1/2-13 nuts and washers for use on foundation bolts.

(e) Place a sling under each side of housing, parallel to long dimension as shown in figure 8-8. Keep slings clear of mounting holes and conduit openings in base.

CAUTION: Do not place the slings parallel to the short dimensions, as the housing will be deformed and the ventilation system damaged.

(f) Wrap a horizontal binder (13-mm or 1/2-inch rope) around housing as shown in figure 8-1. Binder should be on outside of slings and, if possible, attached to at least one sling at each end of housing.

(g) Carefully hoist housing assembly and position it over foundation bolts. Apply sealant (732 RTV) to perimeter area around conduit openings in base to provide a smooth seal between base and concrete pad.

(h) Slowly lower housing assembly onto pad while maintaining alignment between foundation bolts and mounting holes in base. Check clearances as housing is lowered over ground rod and conduits.

(i) Remove slings and binder.

(j) Install flat washer and nut on each of four foundation bolts.

(k) While installation work continues, doors may be stowed by sliding them down onto the boss provided for this purpose on each end of the housing.

8.23 Removing Housing From Assembly. Ordinarily, the housing assembly is shipped and installed with the housing attached to the base. If necessary, because of unusual installation or maintenance problems, the housing can be easily removed. Items referenced in the procedure below are called out on figures 8-6 and 8-7.

(a) 55910 Model 2 housings (figure 8-6)

CAUTION: When removing housing, do not rest the housing on the corners of the front edges.

(1) Remove two bolts on each side of housing, and four on the front (items 1, 2, and 3).

(2) Unfasten open door alarm switches S4 and S5 at bottom of door frames. Each is secured by four 10-32 machine screws.

(3) Lift housing off.

(b) 55910 Model 1 housing (figure 8-7)

(1) Remove two bolts (items 3 and 4) on each side of housing. The shelf-locking nut (item 6) must be held with one wrench while the bolt is turned with another. The conduit running thread (item 1) should not be removed.

(2) Remove two cap screws (item 7) on front of housing.

(3) Unfasten open-door alarm switches S4 and S5 at bottom of door frames. Each is secured by four 8-32 machine screws, two in tapped holes and two with nuts and lockwashers.

(4) Remove wing nuts from studs on intake screen. Push screen out so that studs are clear of holes in base.

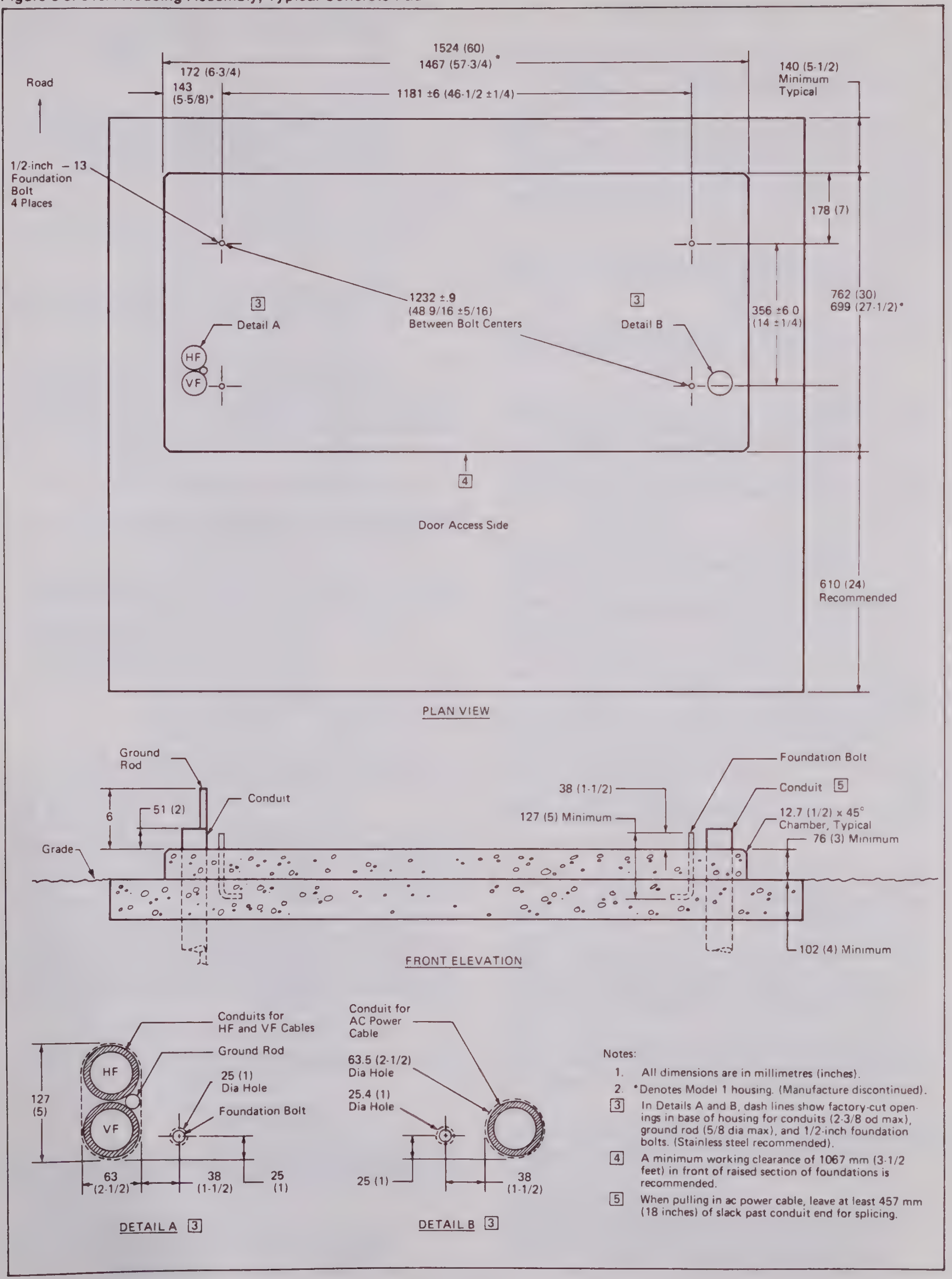
(5) Lift housing off while holding intake screen away from base.

8.24 Wiring and Equipment Installation. Refer to figure 10-7 for wiring information and figures 8-6 (Model 2) and 8-7 (Model 1) for location of equipment and components.

(a) Pull hf and vf cables into housing assembly with enough slack inside housing for forming and fanning at protector blocks on left side of frame.

(Text continues on page 53.)

Figure 8-3. 910A Housing Assembly, Typical Concrete Pad


1524 (60)
1467 (57-3/4)*
172 (6-3/4)
143
(5-5/8)*
1181 ±6 (46-1/2 ±1/4)
140 (5-1/2)
Minimum
Typical
Road
1/2-inch – 13
Foundation
Bolt
4 Places
178 (7)
3
Detail A
HF
VF
1232 ±.9
(48 9/16 ±5/16)
Between Bolt Centers
3
Detail B
356 ±6 0
(14 ±1/4)
762 (30)
699 (27-1/2)*
4
Door Access Side
610 (24)
Recommended
PLAN VIEW
Ground
Rod
6
51 (2)
Conduit
Grade
38 (1-1/2)
127 (5) Minimum
Foundation Bolt
Conduit 5
12.7 (1/2) x 45°
Chamber, Typical
76 (3) Minimum
102 (4) Minimum
FRONT ELEVATION
Conduits for
HF and VF Cables
Ground Rod
25 (1)
Dia Hole
Foundation Bolt
HF
VF
127
(5)
63
(2-1/2)
38
(1-1/2)
25
(1)
DETAIL A 3
Conduit for
AC Power
Cable
63.5 (2-1/2)
Dia Hole
25.4 (1)
Dia Hole
25 (1)
38
(1-1/2)
DETAIL B 3

Notes:

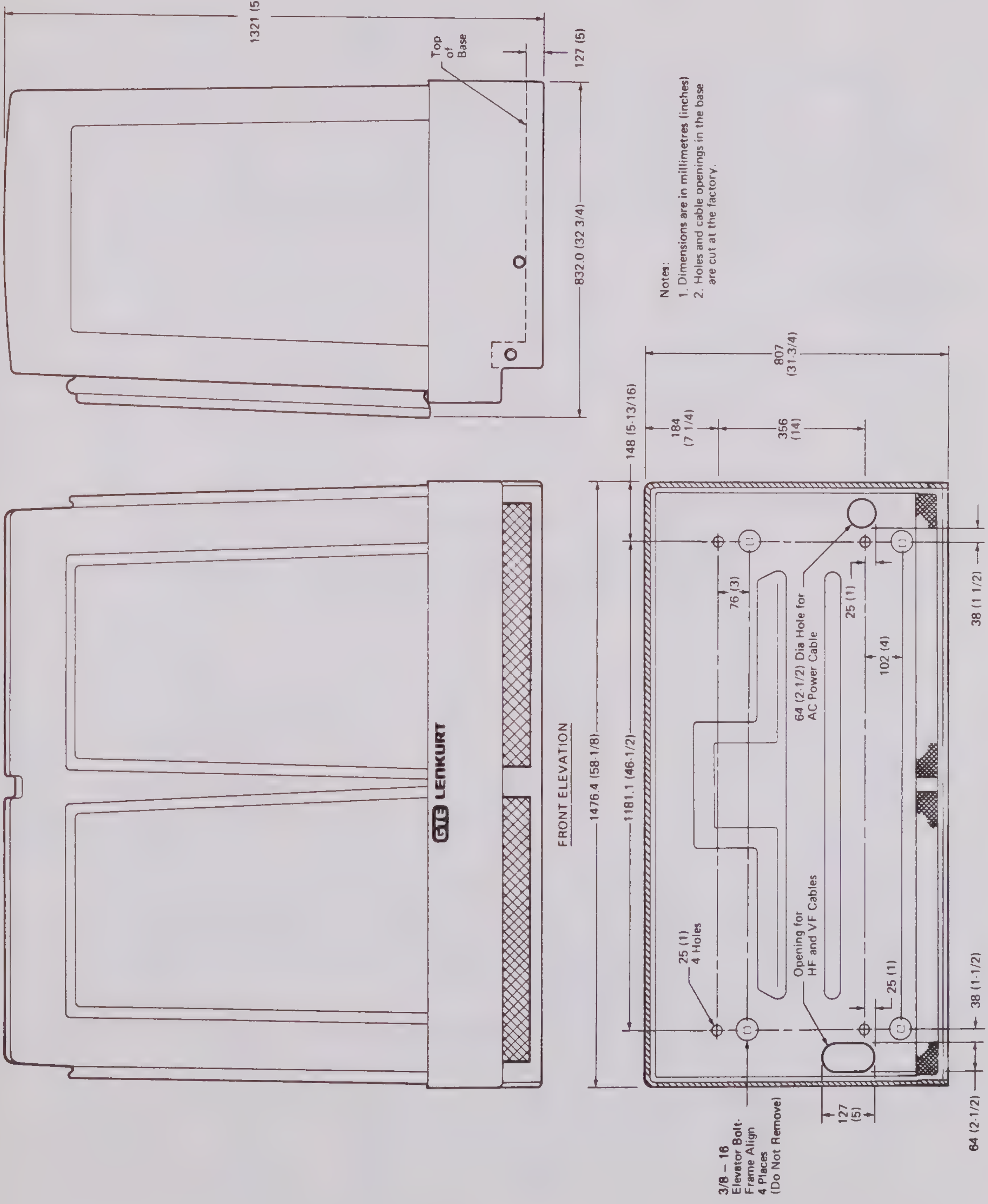
1. All dimensions are in millimetres (inches).
2. *Denotes Model 1 housing. (Manufacture discontinued).

3 In Details A and B, dash lines show factory-cut openings in base of housing for conduits (2-3/8 od max), ground rod (5/8 dia max), and 1/2-inch foundation bolts. (Stainless steel recommended).

4 A minimum working clearance of 1067 mm (3-1/2 feet) in front of raised section of foundations is recommended.

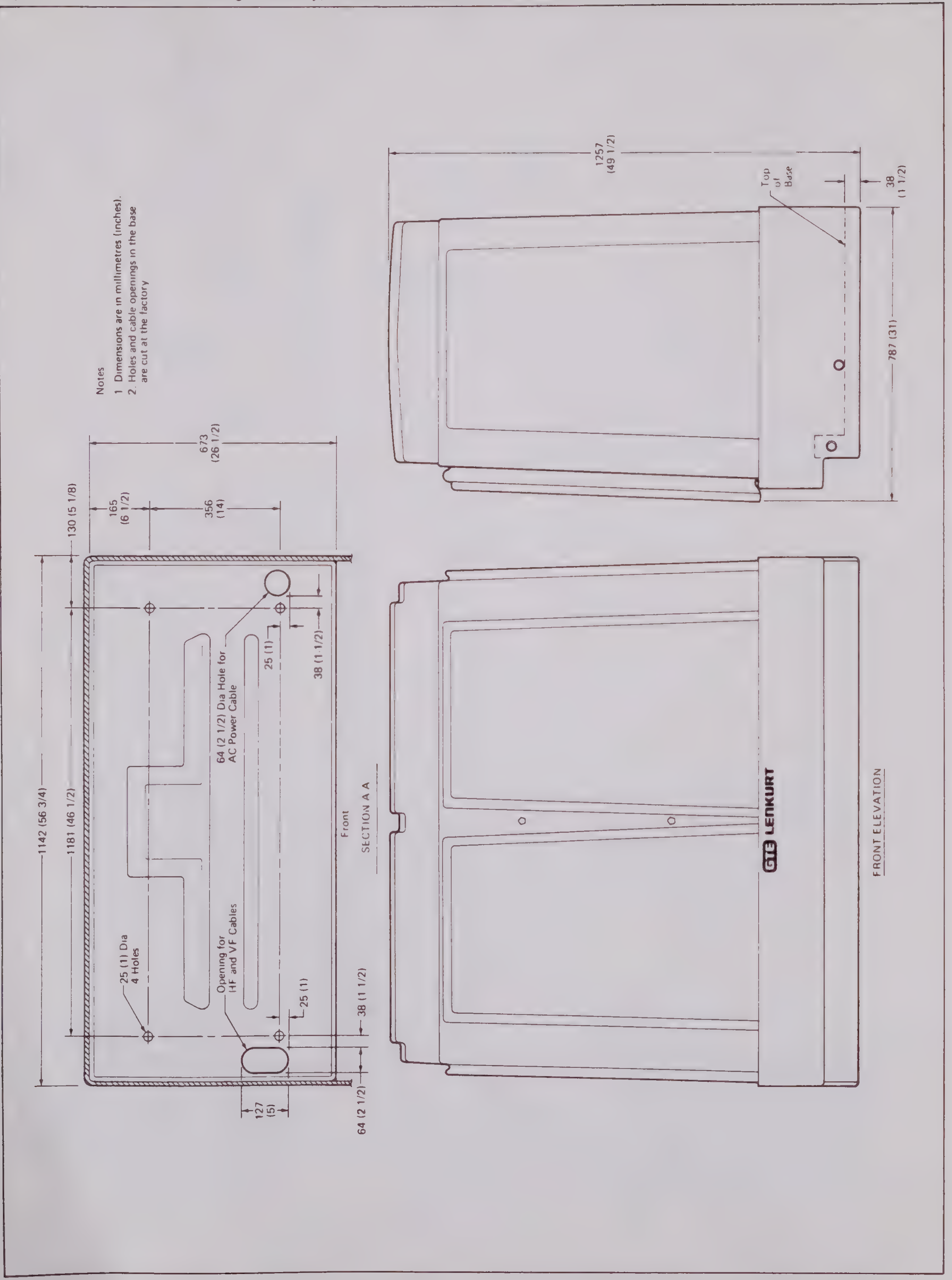
5 When pulling in ac power cable, leave at least 457 mm (18 inches) of slack past conduit end for splicing.

Figure 8-4. 910A Model 2 Housing Assembly, Overall and Mounting Dimensions


1321 (52)
Top of Base
127 (5)
832.0 (32 3/4)
807 (31-3/4)
148 (5-13/16)
184 (7 1/4)
356 (14)
76 (3)
25 (1)
102 (4)
38 (1 1/2)
64 (2-1/2) Dia Hole for AC Power Cable
GTE LENKURT
FRONT ELEVATION
1476.4 (58-1/8)
1181.1 (46-1/2)
25 (1) 4 Holes
Opening for HF and VF Cables
25 (1)
38 (1-1/2)
3/8 – 16 Elevator Bolt-Frame Align 4 Places (Do Not Remove)
127 (5)
64 (2-1/2)
FRONT
PLAN VIEW OF BASE

Notes:
1. Dimensions are in millimetres (inches)
2. Holes and cable openings in the base are cut at the factory.

Figure 8-5. 910A Model 1 Housing Assembly, Overall and Mounting Dimensions



Notes
1. Dimensions are in millimetres (inches).
2. Holes and cable openings in the base are cut at the factory

1257 (49 1/2)
Top of Base
38 (1 1/2)
787 (31)
673 (26 1/2)
165 (6 1/2)
356 (14)
130 (5 1/8)
1142 (56 3/4)
1181 (46 1/2)
64 (2 1/2) Dia Hole for AC Power Cable
25 (1)
38 (1 1/2)
Front
SECTION A A
GTE LENKURT
FRONT ELEVATION
25 (1) Dia 4 Holes
Opening for HF and VF Cables
25 (1)
38 (1 1/2)
127 (5)
64 (2 1/2)

Figure 8-6. 910A Model 2 Housing Assembly, Identification of Components (Sheet 1 of 2)

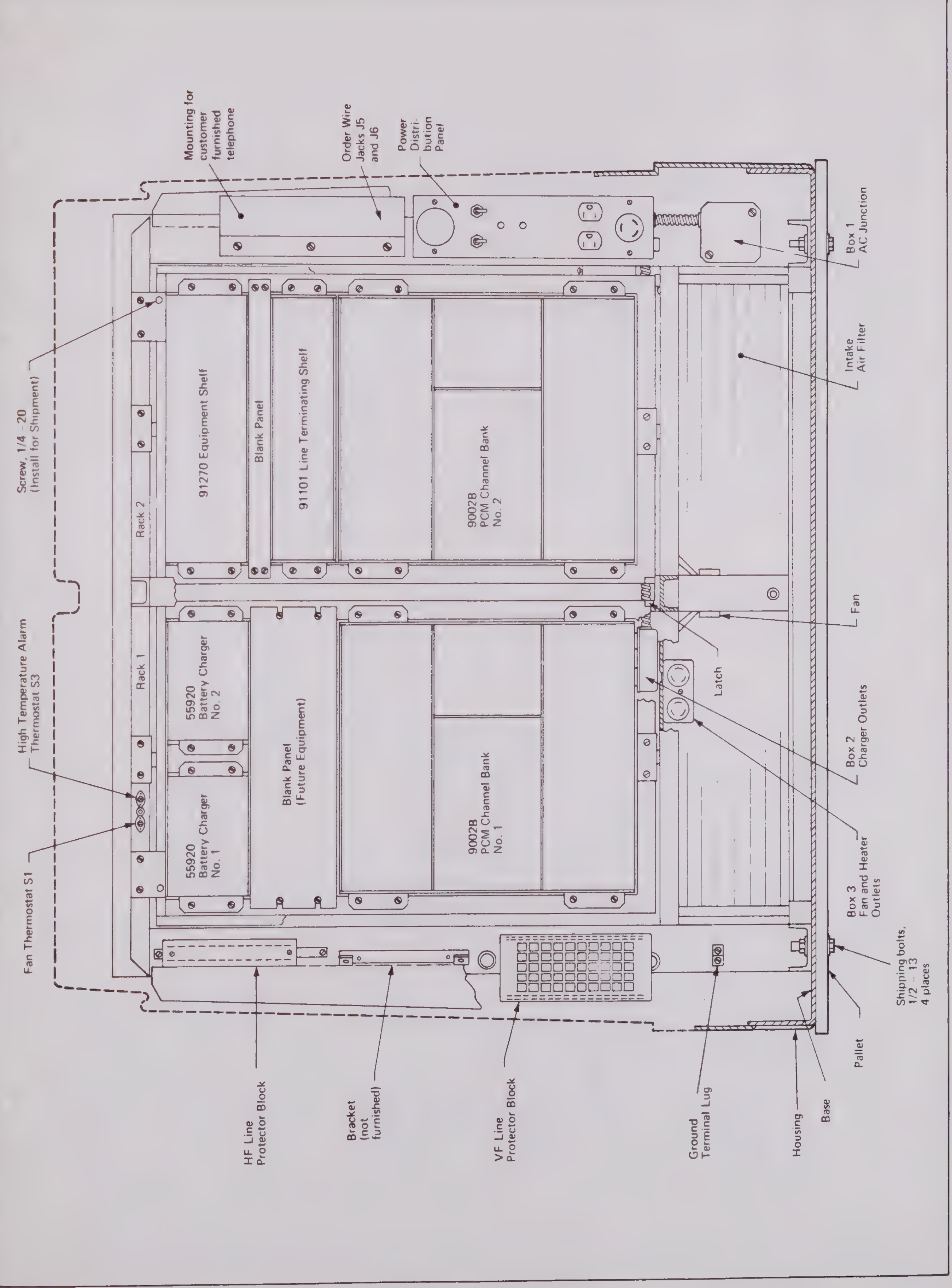
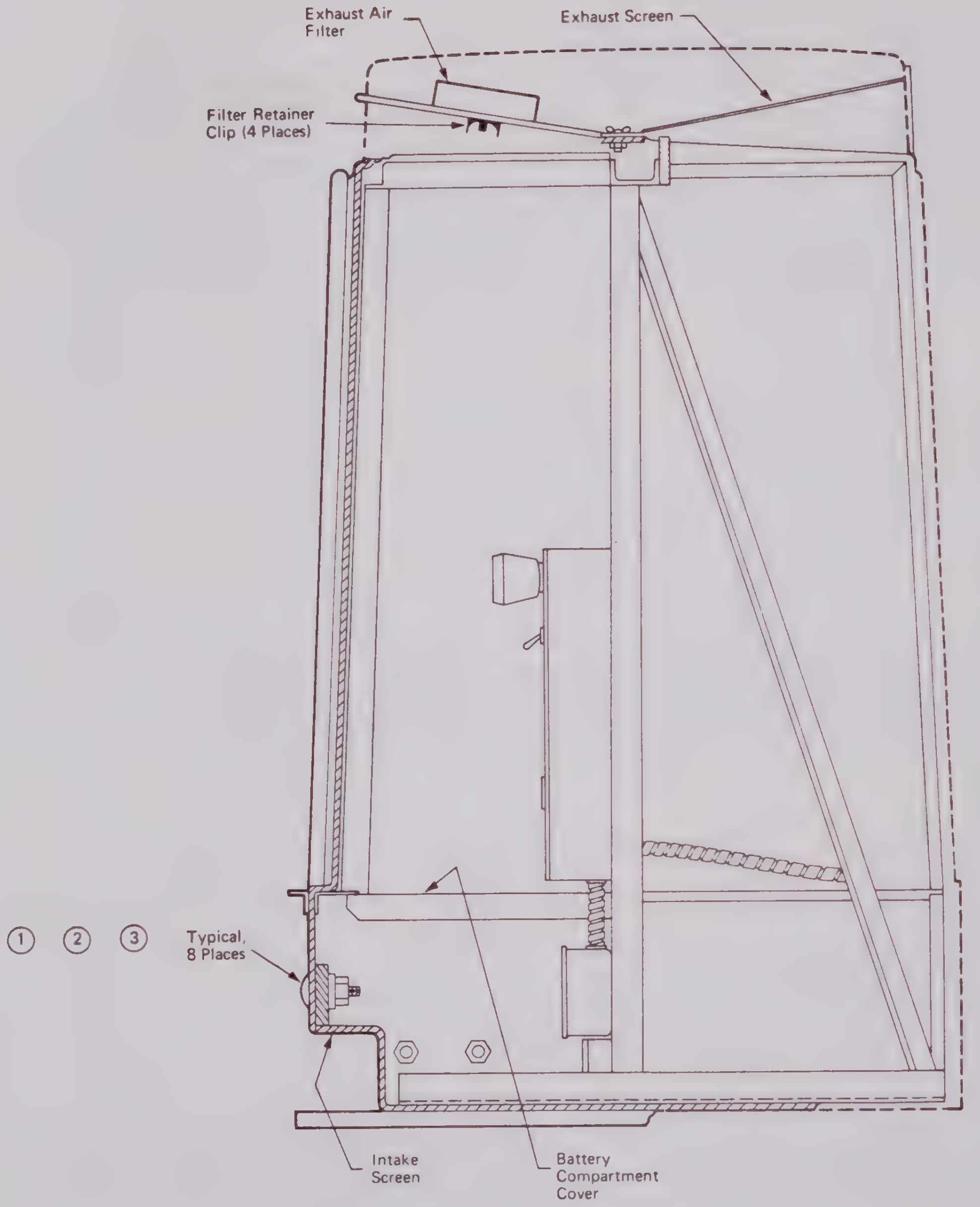

Mounting for customer furnished telephone
Order Wire Jacks J5 and J6
Power Distribution Panel
Box 1 AC Junction
Intake Air Filter
Screw, 1/4 - 20 (Install for Shipment)
Rack 2
91270 Equipment Shelf
Blank Panel
91101 Line Terminating Shelf
9002B PCM Channel Bank No. 2
Fan
Latch
High Temperature Alarm Thermostat S3
Rack 1
55920 Battery Charger No. 2
55920 Battery Charger No. 1
Blank Panel (Future Equipment)
9002B PCM Channel Bank No. 1
Box 2 Charger Outlets
Fan Thermostat S1
Box 3 Fan and Heater Outlets
Shipping bolts, 1/2 - 13 4 places
HF Line Protector Block
Bracket (not furnished)
VF Line Protector Block
Ground Terminal Lug
Housing
Base
Pallet
J5

Figure 8-6. 910A Model 2 Housing Assembly, Identification of Components (Sheet 2 of 2)


Exhaust Air Filter
Exhaust Screen
Filter Retainer Clip (4 Places)
①
②
③
Typical, 8 Places
Intake Screen
Battery Compartment Cover

Notes:

1. Shading indicates polyurethane foam sealing straps.

2. Hardware for attaching housing to base:

Item	Qty	Description
1	6	Carriage Bolt, ¼-20, 1-¾ inch long, CRES
	2	Carriage Bolt, ¼-20, 1-½ inch long, CRES (two center bolts on front)
2	8	Washer, flat, ¼-inch, CRES
3	8	Nut, self-locking, ¼-20

Figure 8-7. 910A Model 1 Housing Assembly, Identification of Components (Sheet 1 of 2)

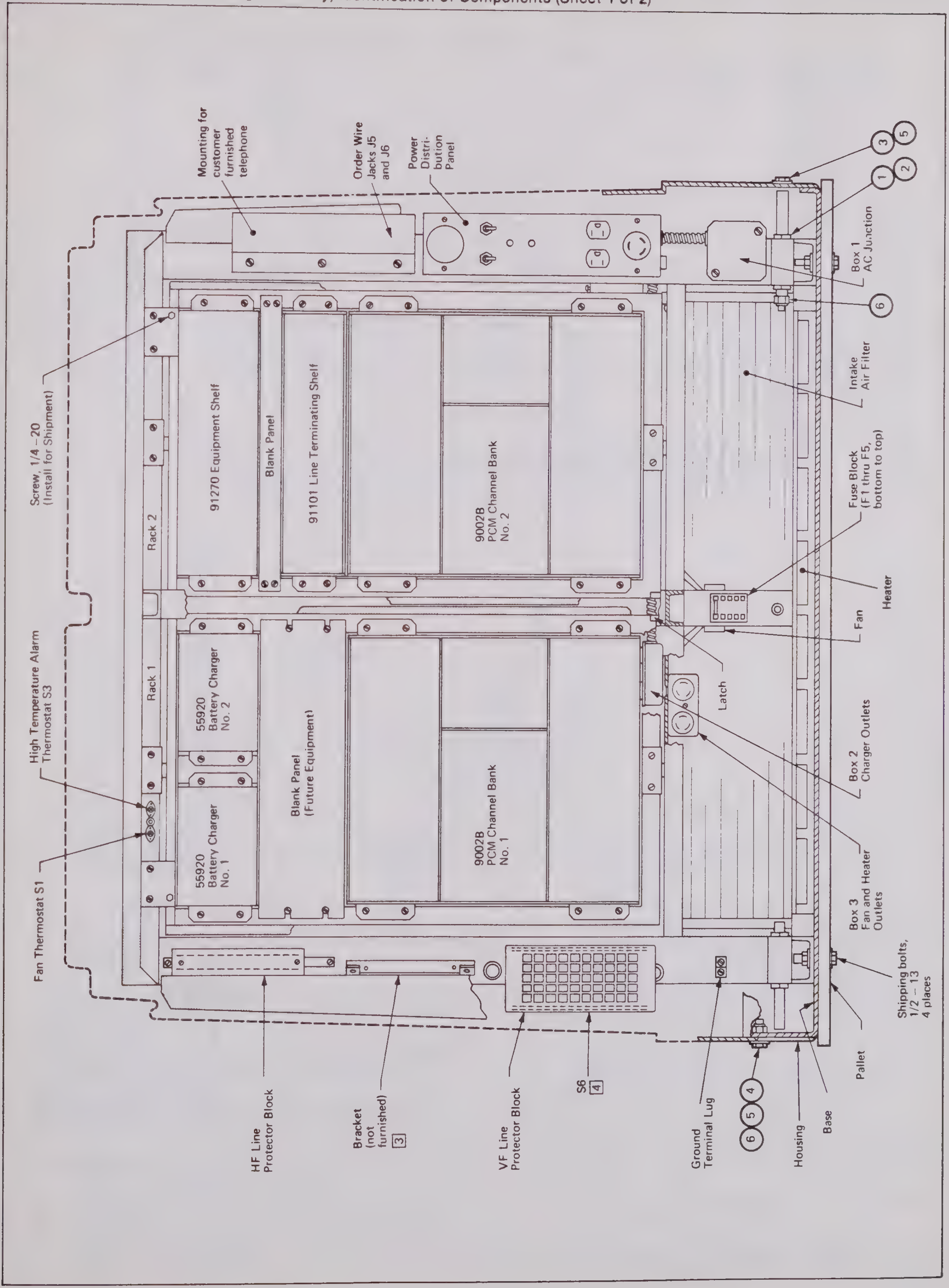
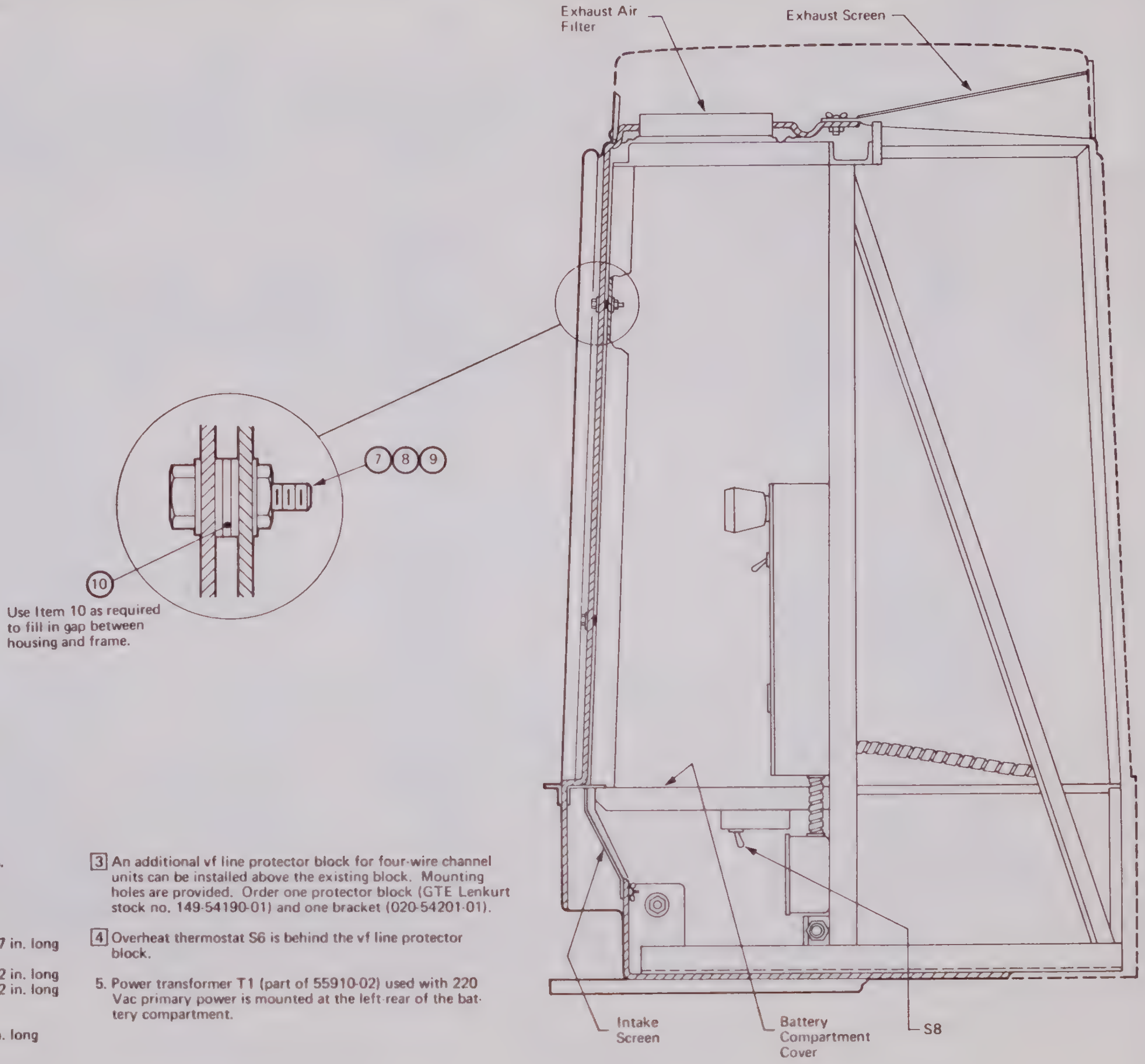

Mounting for customer furnished telephone
Order Wire Jacks J5 and J6
Power Distribution Panel
Screw, 1/4 – 20 (Install for Shipment)
91270 Equipment Shelf
Blank Panel
91101 Line Terminating Shelf
9002B PCM Channel Bank No. 2
Rack 2
Rack 1
High Temperature Alarm Thermostat S3
Fan Thermostat S1
55920 Battery Charger No. 2
55920 Battery Charger No. 1
Blank Panel (Future Equipment)
9002B PCM Channel Bank No. 1
HF Line Protector Block
Bracket (not furnished) 3
VF Line Protector Block
S6 4
Ground Terminal Lug
6 5 4
Housing
Base
Pallet
Shipping bolts, 1/2 – 13 4 places
Box 3 Fan and Heater Outlets
Box 2 Charger Outlets
Latch
Fan
Heater
Fuse Block (F1 thru F5, bottom to top)
Intake Air Filter
6
Box 1 AC Junction
1 2
3 5

Figure 8-7. 910A Model 1 Housing Assembly, Identification of Components (Sheet 2 of 2)


Exhaust Air Filter
Exhaust Screen
7
8
9
10
Use Item 10 as required to fill in gap between housing and frame.
Intake Screen
Battery Compartment Cover
S8

Notes:

1. Shading indicates polyurethane foam sealing strips.

2. Hardware for attaching housing to base:

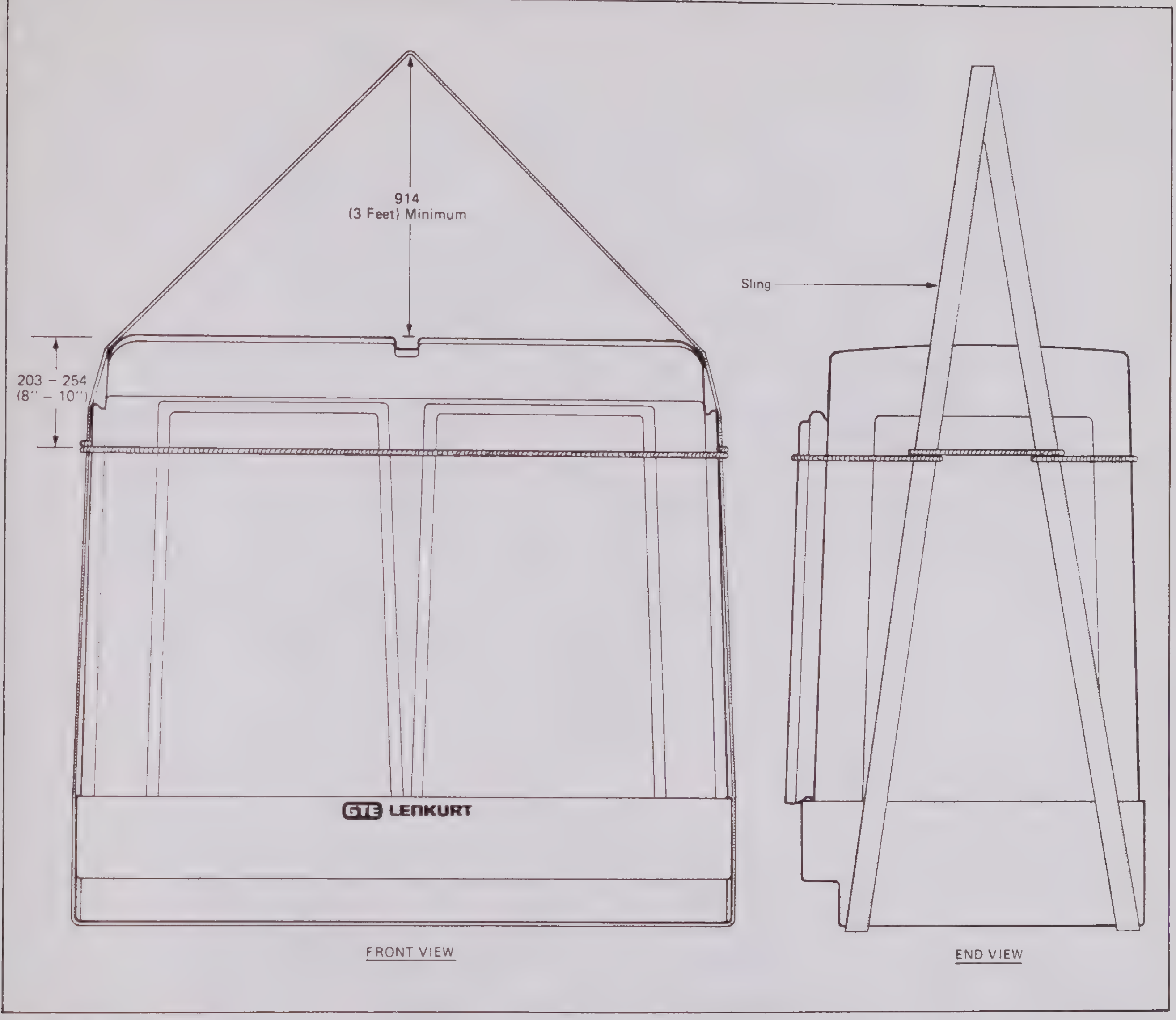
Item	Qty	Description
1	2	Conduit running thread, 1/2-inch, 7 in. long
2	4	Conduit locknut, 1/2-inch
3	2	Bolt, machine, CRES, 1/2-12, 8-1/2 in. long
4	2	Bolt, machine, CRES, 1/2-13, 1-1/2 in. long
5	8	Washer, flat, 1/2-inch
6	4	Nut, self-locking, 1/2-13
7	2	Screw, cap, CRES, 1/4-20, 1-1/2 in. long
8	2	Nut with lock washer, 1/4-20
9	2	Washer, flat, 1/4-inch
10	6	Washer, fiber, 1/4-inch

3 An additional vf line protector block for four-wire channel units can be installed above the existing block. Mounting holes are provided. Order one protector block (GTE Lenkurt stock no. 149-54190-01) and one bracket (020-54201-01).

4 Overheat thermostat S6 is behind the vf line protector block.

5. Power transformer T1 (part of 55910-02) used with 220 Vac primary power is mounted at the left-rear of the battery compartment.

Figure 8-8. 910A Housing Assembly, Placement of Slings for Lifting



(Continued from page 45.)

(b) Connect hf and vf cables to protector blocks (wirewrap terminals).

(c) Open external ac circuit breaker.

(d) On power distribution panel, throw MAIN and AUX EQPT circuit breakers to OFF.

(e) Verify that ac power cable has about 457 mm (18 inches) of slack past conduit end.

(f) Install bushing (or other protective fitting) in an appropriate knock-out opening of ac junction box 1.

(g) Connect ac power cable to black and white wires and ground lug in ac junction box 1.

(h) Connect ground terminal lug at left side of frame to ground rod. Use at least 6-gauge (4.0-mm) wire.

(i) Remove in line fuses F1 and F2 (Model 2 housing). Remove fuses F1 through F5 from fuse block at lower center of frame (Model 1).

(j) On 91272 Power Supply Units (one or two), verify strapping per figure 3-3.

(k) On rack 2, install 91271 Fuse and Alarm Unit and 91272 Power Supply Units in 91270 Equipment Shelf. If only one 91272 unit (ringing and coin control) is required, install it in the center mounting position of the shelf. A bar across the rear of the shelf has a locking screw for each unit; back the screws out and after the units are plugged in, lock them to the shelf.

(l) On 91271 unit, connect blue, green, and yellow wires (push-on connectors) to correspondingly marked terminals of TB1.

(m) Remove fuses from 91271 unit.

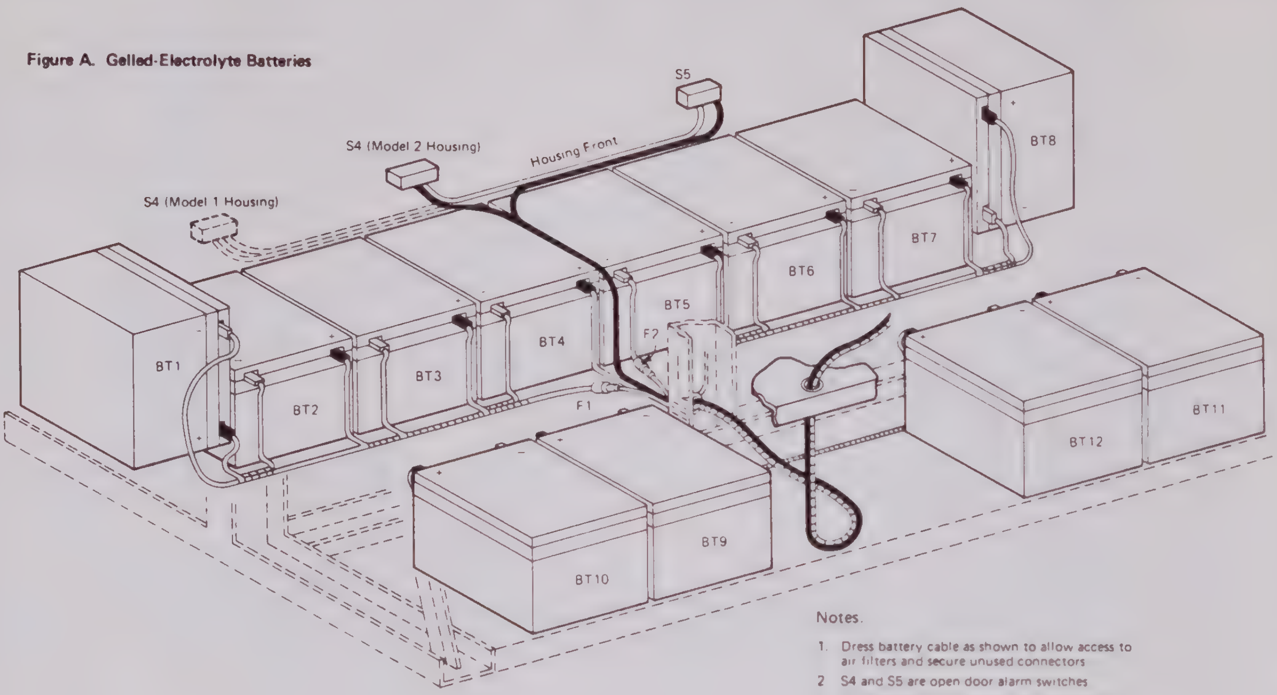
(n) On rack 1, install two 55920 Battery Chargers as follows:

  (1) Mount each charger on rack with four screws.

  (2) Rotate both racks for access to box 2 behind rack 1.

Figure 8-9. 910A Housing Assembly, Battery Installation

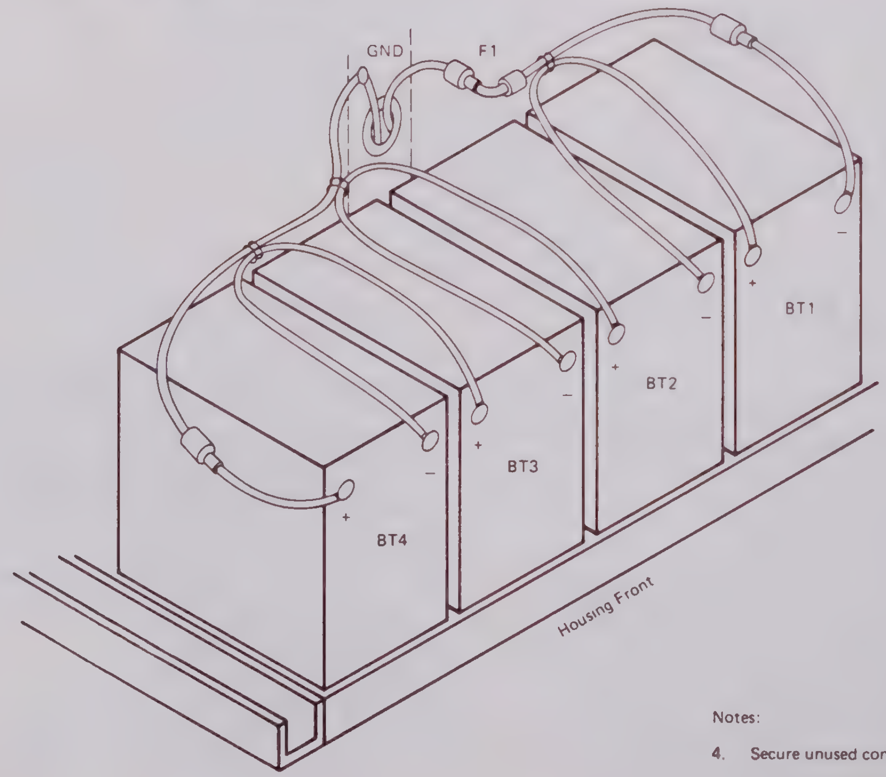
Figure A. Gelled-Electrolyte Batteries


S5
S4 (Model 2 Housing)
Housing Front
S4 (Model 1 Housing)
BT8
BT7
BT6
BT5
BT4
BT3
BT2
BT1
F2
F1
BT11
BT12
BT9
BT10

Notes.

1. Dress battery cable as shown to allow access to air filters and secure unused connectors
2. S4 and S5 are open door alarm switches
3. BT9 through BT12 are not used on the model 2 housing

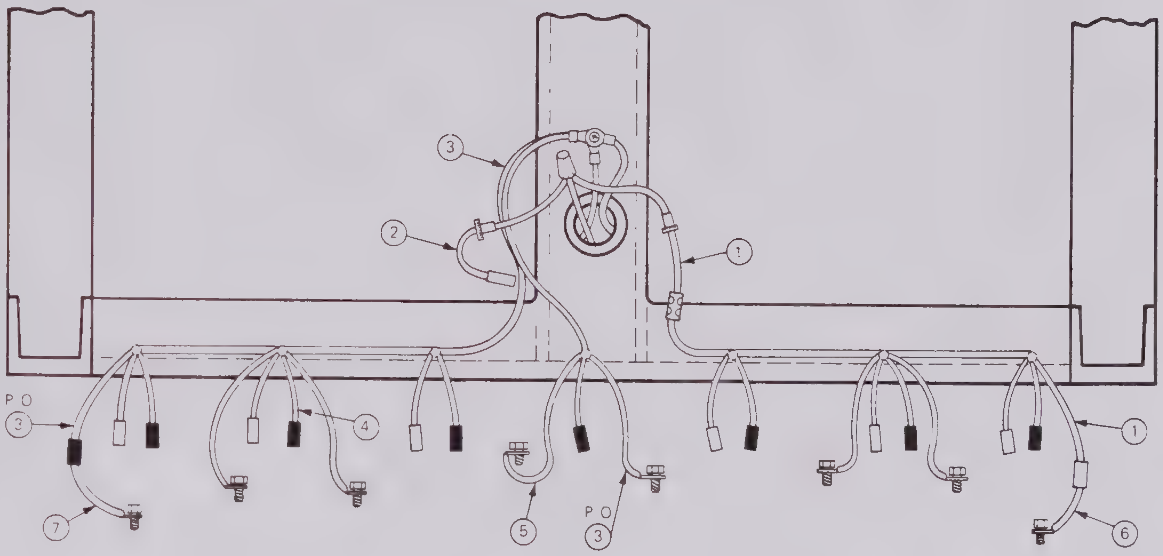
Figure B. Automotive-Type Batteries


GND
F1
−
+
BT1
−
+
BT2
−
+
BT3
−
+
BT4
Housing Front

Notes:

4. Secure unused connectors.
5. Automotive batteries are placed in gelled electrolyte battery positions BT1 through BT8.

Figure 8-10. Wiring Harness Assembly for the 910A, Model 2, Housing



Item	Qty	GTE Lenkurt Stock No
1	1	088 56627 01
2	1	088 56626 01
3	1	088 56624 01
4	6	088 56625-01
5	3	088 56730-01
6	1	088 56466-01
7	1	088 56466-02

(3) Clamp both ac power cords to bottom of 55920 charger no. 1. Use a nylon cable clamp and a 6-32 machine screw about 13-mm (1/2-inch) long in the tapped hole in the outside horizontal flange at the rear of the charger.

(4) Holding connectors of two ac power cords adjacent, pull slack in charger no. 1 cord through cable clamp. Tighten clamp.

(5) Twist ac power cords together about four turns.

(6) Plug cords into outlets in box 2.

(7) Connect yellow, green and black wires (push-on connectors) to terminals on TB1 of chargers.

(8) Check that power cords and racks do not interfere when racks are rotated.

(o) Place the batteries in base as shown in figure 8-9A. If only one set of batteries is used, install in positions BT1 through BT4; two sets, BT1 through BT8. If three sets are used, BT9 through BT12 must be placed and connected before BT1 through BT8 are placed. If the automotive-type batteries are used, place them in gelled-electrolyte battery positions BT1 through BT8 with the terminals toward the front as shown in figure 8-9B.

NOTE: Check all type batteries for leakage (cracked case).

(p) The wiring harness assembly for the 910A, Model 2, housing is shown in figure 8-10. Beginning at each end of the wiring harness, connect wires to battery terminals in break-out order and conforming to color coding of push-on connectors (black is positive, white is negative). A second harness is provided on the 55910 Model 2 housing for the automotive-type batteries. The harness provides the cabling and bolts to connect to the terminal connections on the front of the batteries. Connect batteries in series. Tie back any unused connectors into the harness and make secure.

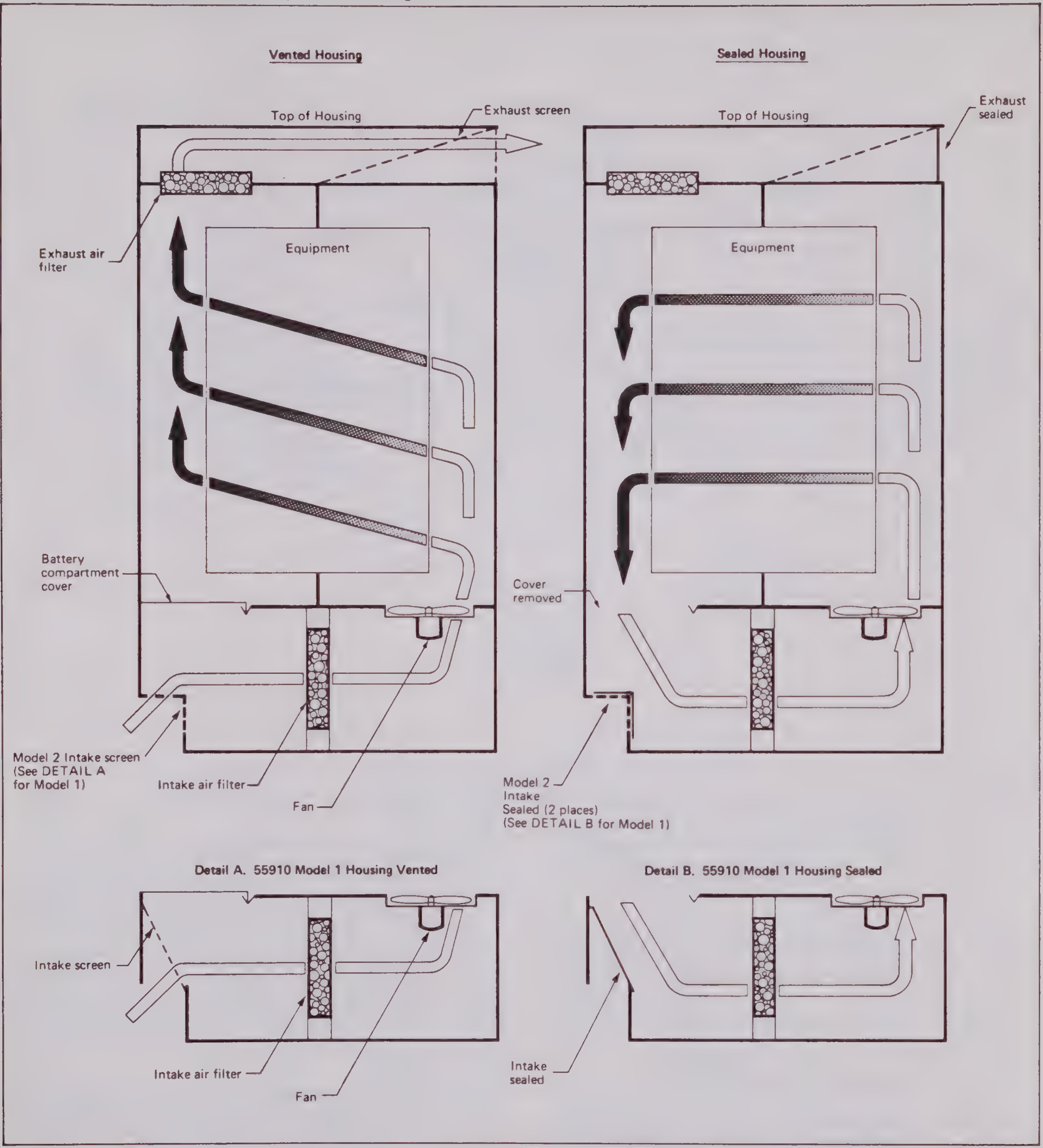
CAUTION: Care must be taken in the installation and tightening of the bolts so that the automotive battery posts are not shorted to ground. Connect far left side (+ ground) terminal last.

(q) As a protection against corrosion, apply a coating of silicone rubber (such as General Electric type RTV-108) over each assembled battery terminal and push-on connector.

(r) On the 55910 Model 2 housing, install 20-ampere in-line fuse or fuses according to batteries used. Place fuses above floor of housing to minimize electrolysis due to water.

BT1 through BT4: F1 only
BT4 through BT8: F1 and F2

Figure 8-11. 910A Housing Assembly, Air Flow Diagram


Vented Housing
Sealed Housing
Top of Housing
Exhaust screen
Top of Housing
Exhaust sealed
Exhaust air filter
Equipment
Equipment
Battery compartment cover
Cover removed
Model 2 Intake screen (See DETAIL A for Model 1)
Intake air filter
Fan
Model 2 Intake Sealed (2 places) (See DETAIL B for Model 1)
Detail A. 55910 Model 1 Housing Vented
Detail B. 55910 Model 1 Housing Sealed
Intake screen
Intake air filter
Fan
Intake sealed

(s) On the 55910 Model 1 housing, install 20-ampere fuses in fuse block according to batteries used. (F1 is the lowest fuse.)

BT1 through BT4: F1 only
BT1 through BT8: F1, F2, and F5
BT1 through BT12: (housing with 9002A equip.) F1 through F5

(t) Having previously verified strapping and equipment options, install plug-in units in channel banks and 91101 shelf. Channels must be equipped as described in paragraphs 5.29 and 5.30.

(u) Verify strapping per notes on figure 10-7.

NOTE: This completes installation and wiring. Initial alignment is covered in Part 9.

8.25 Vented or Sealed Housing. In the housing assembly, cooling air is circulated through the equipment by a thermostatically controlled fan. As shown in figure 8-11, the housing may be vented or sealed. The sealed configuration is preferred, but venting is recommended for summer months if maximum outside ambient temperatures will be persistently above 27°C (80°F).

8.26 As shipped from the factory, the housing assembly is ready for sealed operation except the battery compartment covers must be removed.

(a) To convert the Model 2 housing for vented operation, remove the two foam angle assemblies that cover the intake ports and the metal plates that block the exhaust ports (paragraph 10.39).

(b) To convert the Model 1 housing for vented operation, remove the foam sealing strip that covers the intake port and the metal plates that block the exhaust ports (paragraph 10.39).

NOTE: Items that are removed for vented operation on either the Model 1 or 2 housing can be stowed behind the equipment racks at the right side of the housing.

8.27 On the 55910 Model 2 housing, switch S8 has been removed and the fan is thermostatically controlled by switch S1 so no adjustment is necessary for CLOSED or VENTED position. On the 55910 Model 1 housing, set switch S8 in the battery compartment (figure 8-7) in the VENTED or CLOSED position for vented or sealed operation, respectively.

9. ALIGNMENT

9.01 A complete initial alignment of the 910A system (figure 9-1) consists of looped testing at each terminal to verify performance and wiring integrity, followed by remote-looped testing from the central office to verify end-to-end operation. All of these tests can be performed by one person with one set of test equipment. Paystation signaling tests, if applicable, and ringing tests at the remote terminal conclude the alignment. Although looped ringing and vf tests are optional as indicated in figure 9-1, they enable the performance of individual channels to be evaluated before the repeatered lines are operational. They will also be helpful if trouble isolation is necessary.

Test Equipment

9.02 For complete lineup and acceptance testing capability, the test equipment items listed in figure 6-5 are required. Another item may be substituted if it has suitable accuracy and fully performs the required measurement and test functions.

9.03 In alignment of the channel bank, the acvm and other test equipment (but not the signaling test set) are connected through the 91232 Test and Alignment Set to the vf jacks on the channel units. In the test set, under the control of the CHANNEL TYPE SELECT switches, a transformer provides impedance matching and isolation between the unbalanced 600-ohm test equipment and the balanced 900-ohm vf circuits. Levels can be read directly in dBm and dBrn without applying a correction factor to the meter reading. The MEASURE jacks on the test set are terminated internally so the test equipment is used unterminated; the ground lead of the test cord must be connected to the ground terminal on the test equipment used for measuring.

NOTE: Where an acvm is specified in the alignment procedures, the TTS-37B Noise Measuring Set may be substituted. Use the 600Ω BRDG position of the INPUT switch and the 3KC position of the FILTER switch (C-MSG position for noise or distortion measurements).

Figure 9-1. Outline of 910A System Alignment

Procedure	Paragraph
Initial remote terminal alignment	9.10
Power turn-on	9.15
*Preparation for looped ringing and vf tests	9.16
*Looped ringing test	9.19
*Looped vf tests	9.24
*Receive gain adjustment	9.26
*Transmit gain adjustment	9.28
*Idle channel noise	9.30
*Distortion	9.32
Looped terminal equipment test	9.34
Conclusion of testing	9.35
Initial office terminal alignment	9.37
*Looped ringing detection test	9.40
*Looped vf tests	9.43
*Receive gain adjustment	9.26
*Transmit gain adjustment	9.28
*Idle channel noise	9.30
*Distortion	9.32
Looped terminal equipment test	9.44
Auxiliary alarm test	9.45
Repeatered line and spare line switching tests (at central office)	9.47
Simplex loop current	9.48
Spare line switching test	9.52
Remote-looped transmission tests (at central office)	9.53
Functional channel operation	10.15
Channel net loss	10.16
Idle channel noise	10.17
*Signaling bias distortion	10.18
Full-prepay channel unit signaling tests	
Coin box trunk test set	10.19
Automatic coin test line	10.22
WECo coin station test line	10.23
Semi-postpay channel unit signaling tests	10.25
Ringing test	10.26
*Optional	

General Instructions

9.04 The alignment procedures within each category of tests are presented in the sequence in which they should be performed. If a test is interrupted for any reason, or if it is desired to look only at part of a test within the sequence, the channel bank and the test set must first be configured as indicated at the beginning of the test.

9.05 In the looped test procedures, voice transmit and voice receive paths are tested completely but signaling functions are tested only partially. Except for full-prepay channel units, transmit-to-receive channel pairs (figure 9-2) can include different channel unit types. Note that channel pairs are not the same in the D2 and D3 channel banks.

9.06 During initial alignment, if the specified requirements of a test cannot be achieved, carefully recheck the procedures and verify optional strapping. If necessary, substitute known good units for the applicable units being tested.

9.07 If it is necessary to replace a suspected unit with one that has not yet been verified as operational, check to see whether the replacement unit has any effect on tests already completed. If necessary, repeat these tests with the replacement unit.

9.08 Unless otherwise specified, channel bank controls and indicators are on the 91230 Alarm and Control Unit.

9.09 Alignment procedures refer to the 91133 1-for-2 Switching Logic Unit. If the remote terminal is located in an office, the 91120 Spare Line Transfer Shelf with

91121 Switching Logic Unit and 91122 Spare Line Logic Unit may be used instead. Instructions about the 91133 unit pertain to the 91121 and 91122 units in a similar manner. For example, if a procedure says unplug the 91133 unit, unplug both the 91121 and 91122 units.

Initial Remote Terminal Alignment

9.10 Initial alignment of the remote terminal is independent of the central office terminal and does not require the repeatered lines to be operational. However, at the conclusion of the tests, the repeatered lines are checked before the housing at the remote location is closed.

9.11 When access to the two-wire vf interface at a remote terminal is required, instructions are given to connect test equipment to the CARR 2-WIRE jack on the channel unit. The 91266 channel unit and Model 1 of the 91260 and 91262 channel units are not equipped with this normalled-through jack. For these channel units only, after disconnecting the subscriber loop, connect the test equipment to the 2W MON pin jacks instead. The subscriber loop at a remote housing can be disconnected by pulling the vf protector module out to the first notch; at a remote office, pull the heat coil.

9.12 Remote terminal alignment procedures that follow apply specifically to a 910A housing assembly equipped with two channel banks and generally to other remote terminal configurations.

9.13 On the 9002A channel bank, Models 1 and 2 of the 91220 Terminal Equipment Shelf are wired for the D2 channel sequence; Model 3 has optional D2 or D3 sequence, but D3 is preferred. On the 9002B channel bank, the 91330 Terminal Equipment Shelf should be arranged for D3 channel sequence. Channel banks at each end of the system must use the same sequence.

9.14 Refer to paragraph 5.29 for location and minimum quantity of channel units.

WARNING: At the remote terminal, high ringing voltage (−260V or −310V) can be encountered on the exposed printed circuits of subscriber channel units. Be careful when installing or removing these units or working on the subscriber loop wiring. When a unit is removed, wait a few seconds for ringing circuit capacitors to discharge before you touch any circuit traces. In addition, you must take extra precautions to prevent equipment damage. Shorting or grounding the ringing supply voltage on a channel unit can cause total failure of that unit and possibly many other units. If the condition is prolonged, printed circuit boards may overheat and char.

(a) Do not use unoccupied channel unit mounting positions in the shelf as a resting place for tools, test equipment, or material.

(b) Before you insert a unit, inspect unit and mating shelf connector for foreign material, such as wire clippings.

(c) Keep channel units dry.

9.15 Power Turn On.

(a) Remove all fuses from the 91271 Fuse and Alarm Unit.

(b) Unplug the 91133 1-for-2 Switching Logic Unit from its shelf connector.

(c) Close external ac circuit breaker.

(d) Throw MAIN and AUX EQPT circuit breakers on power distribution panel to ON.

(e) Measure outputs of both 55920 Battery Chargers at −53V and GRD test points. Voltage should be −56 ±2 Vdc. (This is a no-load voltage; the battery float voltage is −53 Vdc.)

(f) Insert CHARGER 1 and CHARGER 2 fuses on 91271 unit and then the remaining fuses.

(g) Check that alarm lamps on 91271 and 91272 units are off.

(h) Check that POWER lamp on each channel bank is off. The on/off condition of all other lamps is immaterial.

(i) Verify setting of VENTED/CLOSED switch S8 (paragraph 8.25) on the 55910 Model 1 housing.

9.16 Preparation for Looped Ringing and Vf Tests. Preparation for these optional tests consists of configuring the 91230 Alarm and Control Unit of the channel bank and making preliminary checks and adjustments on the 91232 Test and Alignment Set. If the 91232 test set fails to respond as indicated or is suspected of faulty operation during test set preparation or the performance of any of the subsequent tests, return the test set to GTE Lenkurt for service.

9.17 On each channel bank at the remote terminal.

(a) Loop the channel bank by performing whichever of the following steps is applicable.

(1) If SYSTEM ALARM lamp is on, press ACO button (ACO lamp should light) and then press LOOP button (green LOOP lamp should light).

(2) If SYSTEM ALARM lamp is off, momentarily insert one end of a suitable test cord into RCV SPAN jack on associated 91112 Office Terminating Repeater Unit. SYSTEM ALARM lamp should light. Press ACO button (ACO lamp should light) and then press LOOP button (green LOOP lamp should light).

(b) Verify indicator lamps.

Off: REMOTE, LOCAL, POWER
On: SYSTEM ALARM, LOOP, ACO

9.18 On the 91232 Test and Alignment Set.

(a) Turn DIGITAL FUNCTION to OFF.

(b) Connect alignment cord (furnished with test set) between ALIGN connectors on test set and channel bank to be tested.

(c) If POWER lamp is not lighted, push POWER ON/OFF switch. (The Model 2 test set does not have a power switch.)

CAUTION: The 91232 test set supplies operating power to external test equipment from its −48V OUT jack; the test set end of the power cable should be connected last and disconnected first to prevent blowing the fuse on the 91230 Alarm and Control Unit.

(d) Connect an unterminated 600-ohm acvm to MEASURE LEVEL jack. (Ring and sleeve contacts of this jack are grounded.) If the TTS-37B noise measuring set is used in place of the acvm:

  (1) Connect a 725A Test Cord (power cable with TRS plug on each end) between 48V jack on TTS-37B and −48V OUT jack on test set.

  (2) Set switches on TTS-37B as follows: POWER to ON, INPUT to 600Ω BRDG, HOLD to OFF, FILTER to 3KC, and SENS to 0 dBm.

  (3) Connect a 6100C-02 Test Cord (TRS-TT plug on each end) between LINE jack on TTS-37B and MEASURE LEVEL jack on test set.

(e) Turn TRANSMIT ATTENUATOR to 0 dB.

(f) Push 2W 600Ω (▲) button on TRANSMIT side of CHANNEL TYPE SELECT buttons.

(g) Press 600Ω CALIBRATION PUSH TO ADJUST. If necessary, adjust OSC LEVEL for 0 dB on acvm or TTS-37B. (The OSC LEVEL control is a multiturn potentiometer that adjusts the output level of the internal 1025-Hz oscillator.)

(h) Turn DIGITAL FUNCTION to 1 kHz on END/END side of switch.

(i) Push 1 kHz CHECK button. Green lamp should light.

(j) Turn DIGITAL FUNCTION to QUIET on END/END side of switch.

(k) Push 1 kHz CHECK button. Green lamp must not light.

NOTE: If the green lamp lights in the preceding step, ensure that LOOP button on channel bank is pressed and LOOP lamp is on. If not, press LOOP button and return to step (i).

9.19 Looped Ringing Test. This optional test verifies that the 91260, 91262, and 91264 channel units perform their function of detecting and supplying ringing information to the subscriber loops. For the reason given in the next paragraph, the test cannot be applied to the 91266 and 91268 channel units; these units should be tested end-to-end as described in paragraph 9.21.

9.20 In the test procedure, a 120-Hz ringing signal is applied to the two-wire vf input of one channel unit of the looped pair. The usual ringing frequencies cannot be used because they are below the vf range of the transmit bandpass filter in the channel unit. In the other channel unit (91260, 91262, or 91264) of the looped pair, electronic chopper circuits respond to the 120 Hz, but the frequency is too high for the relay chopper circuits in the 91266 and 91268 channel units.

9.21 In addition to the looped ringing test at the remote terminal described below and the looped ringing detection test at the office terminal (paragraph 9.40), a normal operational test of end-to-end ringing is performed later. Office jumpers must be installed temporarily to connect a test line to each channel, in turn. See paragraph 10.26.

9.22 Although most channel units have a normalled-through CARR 2-WIRE jack, inserting a plug in the jack disables the ringing circuits. Consequently, test equipment must be connected to the vf input/output at the 2W MON pin jacks.

9.23 Perform the looped ringing test on 91260, 91262, and 91264 channel units as follows:

NOTE: Before this test, the procedures in paragraph 9.18 should have been completed.

(a) On the test set, turn DIGITAL FUNCTION to 1 kHz ALL CHAN on LOOP side of switch.

(b) Connect a 6100B-02 Test Cord (TRS-TT plug to GR plug) between balanced output of an external 600-ohm oscillator and EXTERNAL OSCILLATOR jack on test set. (The oscillator can be powered from the 117 Vac available at the remote terminal power distribution panel.)

(c) Apply power to audio oscillator and set its output frequency to about 120 Hz.

(d) Verify indicator lamps on channel bank being tested.

Off: REMOTE, LOCAL, POWER
On: SYSTEM ALARM, LOOP, ACO

NOTE: If REMOTE lamp is on, check to see that the PUSH TO TEST TERMINAL button is in the out position and the green lamp is out. If the preceding lamp indications are not obtained, refer to the troubleshooting procedures in Part 10.

(e) On the channel bank, set slide switch on 91230 unit to LOOP SIG (or TEST) position.

(f) Disconnect subscriber loops by pulling vf protector modules out to first notch (remote housing) or by pulling heat coils (remote office), as applicable.

(g) On the test set, push 2W 600Ω (▲) button on TRANSMIT side of CHANNEL TYPE SELECT buttons. Then, press and hold 600Ω CALIBRATION PUSH TO ADJUST button. Adjust output level of audio oscillator for a 0-dBm reading on acvm or TTS-37B. Release PUSH TO ADJUST button.

(h) Connect a 729B Test Cord (TRS-TT plug to twin pin plug) between TRANSMIT jack on test set and 2W MON pin jacks of channel unit 1 (transmit).

(i) Auxiliary alarm inputs to all channel units must be in non-alarm condition (pin 43 grounded) or steps (k) and (l) will fail; for channel 1 in a 910A housing assembly, the door interlock switches must be pushed in and held in the closed position.

(j) Using a multimeter set to measure approximately 300 Vdc, insert positive test lead into upper (tip) 2W MON jack and negative lead into lower (ring) 2W MON jack of receive channel unit (2 for D2; 13 for D3). For ringing supply voltage of −260V or −310V, respectively, multimeter should read between 145 and 195 volts or between 175 and 230 volts.

(k) With multimeter connected as in the preceding step, press 600Ω CALIBRATION PUSH TO ADJUST button on test set. Relay in receive channel unit should release, multimeter should read about 53 Vdc (talk battery), and noise measuring set should read about 0 dBm.

NOTE: If the multimeter does not indicate as above, set slide switch on 91230 unit to NORM and then back to LOOP SIG (or TEST). If the multimeter still does not indicate correctly, substitute a replacement channel unit for the one to which the multimeter is connected, and then, if necessary, for the one to which the test set is connected.

(l) Unplug 729B Test Cord from channel unit 1 and multimeter leads from receive channel unit. Reverse test lead connections so that 729B Test Cord is connected to receive channel unit and multimeter to transmit channel unit.

(m) Repeat steps (j) and (k) with the *reversed* lead arrangement.

(n) Repeat steps (h) through (m) for the remaining eleven pairs of channel units. See figure 9-2.

(o) Transfer alignment cord to ALIGN jack on next channel bank to be tested.

(p) Repeat steps (d) through (n) for next channel bank.

(q) Disconnect all test equipment from channel banks and disconnect external oscillator from test set. On both channel banks, restore slide switch on 91230 unit to NORM.

(r) Unless the optional looped vf tests described in paragraph 9.24 are to be accomplished at this time.

  (1) On each channel bank, press LOOP button. LOOP lamp should go out. After about 15 seconds, all lamps should be out if the transmission line is working.

  (2) Reconnect subscriber lines by reinstalling vf protector modules or heat coils, as applicable.

9.24 Looped VF Tests. The four optional looped vf tests, which are not required as part of initial alignment, are receive gain adjustment (paragraph 9.26), transmit gain adjustment (paragraph 9.28), idle channel noise test (paragraph 9.30), and distortion measurement (paragraph 9.32). The two gain adjustments need not be performed if the factory-set channel net loss of 0 dB ±0.5 dB is satisfactory. The idle channel noise test can be omitted because an equivalent measurement is made during the remote-looped vf tests at the central office. The distortion test is not normally necessary but may be useful in troubleshooting common equipment failures.

9.25 If the looped vf tests are being made as a continuation of the looped ringing tests beginning in paragraph 9.23, the channel bank and test set are already conditioned for the tests; begin the procedure at paragraph 9.26. Otherwise, first prepare for testing as in paragraphs 9.16 through 9.18. Test each channel bank, in turn.

9.26 Receive Gain Adjustment. Before the receive gain adjustment, set up or verify the following test conditions.

(a) On the channel bank to be tested.

  (1) LOOP button pressed as indicated by LOOP lamp on. If channel bank is not looped, perform procedure of paragraph 9.17, step (a).

  (2) The on/off condition of all other lamps is immaterial at this time.

(b) On the 91232 Test and Alignment Set.

  (1) Alignment cord connected to channel bank to be tested.

  (2) POWER lamp on.

  (3) TRANSMIT ATTENUATOR set to 0 dB.

  (4) Acvm or TTS-37B connected to MEASURE LEVEL jack. (Ring and sleeve contacts of this jack are grounded.)

  (5) PUSH TO TEST TERMINAL button in outer position and lamp off.

9.27 Perform the receive gain adjustment as follows.

(a) On the test set, turn DIGITAL FUNCTION to 1 kHz ALL CHAN on LOOP side of switch.

(b) Momentarily press PUSH TO LOOP TERMINAL button.

(c) Verify indicator lamps on channel bank.

Off: REMOTE, LOCAL, POWER
On: SYSTEM ALARM, LOOP, ACO

(d) Press PUSH TO TEST TERMINAL button. Green lamp should light. Yellow REMOTE lamp should light.

(e) Push 2W 900Ω (■) button on RECEIVE side of CHANNEL TYPE SELECT buttons.

(f) Connect RECEIVE jack on test set to CARR 2-WIRE jack on first channel unit to be tested.

(g) Adjust RCV LEV on channel unit for reading of 0.0 dB (or as locally specified) on acvm or TTS-37B.

(h) Unplug cord from channel unit.

(i) Repeat steps (f) through (h) for each channel unit in the channel bank.

(j) Press PUSH TO TEST TERMINAL button. Green lamp should go out.

9.28 Transmit Gain Adjustment. Before the transmit gain adjustment, set up or verify the following test conditions.

(a) On the channel bank to be tested.

  (1) LOOP button pressed as indicated by LOOP lamp on. If channel bank is not looped, perform procedure of paragraph 9.17, step (a).

  (2) Verify indicator lamps.

  Off: REMOTE, LOCAL, POWER
  On: SYSTEM ALARM, LOOP, ACO

(b) On the 91232 Test and Alignment Set.

  (1) Alignment cord connected to channel bank to be tested.

(2) POWER lamp on.

(3) TRANSMIT ATTENUATOR set to 0 dB.

(4) DIGITAL FUNCTION set to 1 kHz ALL CHAN on LOOP side of switch.

(5) Acvm or TTS-37B connected to MEASURE LEVEL jack.

(6) PUSH TO TEST TERMINAL button in outer position and lamp off.

9.29 Perform the transmit gain adjustment for two-wire channel units as follows.

(a) Push 2W 900Ω (■) button on RECEIVE and TRANSMIT sides of CHANNEL TYPE SELECT buttons.

(b) Connect TRANSMIT jack on test set to CARR 2-WIRE jack on channel unit 1 (transmit).

(c) Connect RECEIVE jack on test set to CARR 2-WIRE jack on receive channel unit (2 for D2; 13 for D3).

(d) Adjust XMT LEV on transmit channel unit for reading of 0.0 dB (or level used in step (g) of paragraph 9.27) on acvm or TTS-37B.

(e) Unplug cords from channel units.

(f) Repeat steps (b) through (e) for each of the channel pairs listed in figure 9-2.

(g) Disconnect acvm or TTS-37B from MEASURE LEVEL jack.

Figure 9-2. Looped Terminal Transmit-to-Receive Channel Pairs

Transmit Channel	Receive Channel		Transmit Channel	Receive Channel	
	D2	D3		D2	D3
1	2	13	13	14	1
2	1	14	14	13	2
3	4	15	15	16	3
4	3	16	16	15	4
5	6	17	17	18	5
6	5	18	18	17	6
7	8	19	19	20	7
8	7	20	20	19	8
9	10	21	21	22	9
10	9	22	22	21	10
11	12	23	23	24	11
12	11	24	24	23	12

9.30 Idle Channel Noise. Before the idle channel noise test, set up or verify the following conditions on the channel bank to be tested.

(a) LOOP button pressed as indicated by LOOP lamp on. If the channel bank is not looped, perform the procedure of paragraph 9.17, step (a).

(b) Verify indicator lamps.

Off: REMOTE, LOCAL, POWER
On: SYSTEM ALARM, LOOP, ACO

9.31 Perform the idle channel noise test as follows.

(a) Connect noise measuring set to MEASURE LEVEL jack on test set. Set switches on noise measuring set as follows: INPUT to 600Ω BRDG, HOLD to OFF, and FILTER to C MSG.

(b) Push 2W 900Ω (■) button on RECEIVE and TRANSMIT sides of CHANNEL TYPE SELECT buttons.

(c) Turn off power to 91232 Test and Alignment Set. If test set is Model 2, turn off 1-kHz oscillator by inserting a 600-ohm terminating plug or an open plug in the EXTERNAL OSCILLATOR jack.

(d) Connect RECEIVE jack on test set to CARR 2-WIRE jack on channel unit 1 (receive).

(e) Connect TRANSMIT jack on test set to CARR 2-WIRE jack on transmit channel unit (2 for D2; 13 for D3).

(f) Noise measuring set should read 23 dBrnc or less (for 0-dBm receive level).

(g) Interchange test cords at CARR 2-WIRE jacks on transmit and receive channel units.

(h) Same as step (f).

(i) Unplug cords from channel unit.

(j) Repeat steps (d) through (i) for each of the channel pairs listed in figure 9-2.

(k) If high noise is encountered on all channels of a remote terminal, verify that battery noise at the terminal is below 30 dBrnc. Then, perform the following test to determine which common equipment unit is at fault.

(1) Turn on power to 91232 test set.

(2) Turn DIGITAL FUNCTION switch to QUIET on LOOP side of switch.

(3) Press PUSH TO TEST TERMINAL button. Green lamp should light.

(4) If idle noise exceeds 17 dBrnc, substitute spare receive unit and then, if necessary, spare power supply unit.

(5) If idle noise is less than 17 dBrnc, substitute spare transmit unit.

(6) Return to step (c). However, if the receive unit (or transmit unit) was replaced in this procedure, the receive level (or transmit level) may need readjustment.

(l) Turn on power to test set.

9.32 Distortion. Before making the distortion measurement, set up or verify the following test conditions.

(a) On the channel bank to be tested.

(1) LOOP button pressed as indicated by LOOP lamp on. If channel bank is not looped perform procedure of paragraph 9.17, step (a).

(2) Verify indicator lamps.

Off: REMOTE, LOCAL, POWER
On: SYSTEM ALARM, LOOP, ACO

(b) On the 91232 Test and Alignment Set.

(1) Alignment cord connected to channel bank to be tested.

(2) POWER lamp on.

(3) TRANSMIT ATTENUATOR set to 0 dB.

(4) DIGITAL FUNCTION set to OFF.

(5) PUSH TO TEST TERMINAL button in outer position and lamp off.

9.33 Perform the distortion measurement as follows.

(a) Connect noise measuring set to MEASURE DISTN jack.

(b) Set switches on noise measuring set as follows: INPUT to 600Ω BRDG, HOLD to OFF, and FILTER to C MSG.

(c) Push 2W 900Ω (■) button on TRANSMIT and RECEIVE sides of CHANNEL TYPE SELECT buttons.

(d) Connect TRANSMIT jack on test set to CARR 2-WIRE jack on channel unit 1 (transmit).

(e) Connect RECEIVE jack on test set to CARR 2-WIRE jack on receive channel unit (2 for D2; 13 for D3).

(f) Press and hold DISTORTION REFERENCE PUSH TO ADJUST button and adjust DISTORTION REFERENCE ADJUST control for reading of 80 dBrnc on noise measuring set.

(g) Release pushbutton and read 47 dBrnc or less.

(h) Turn TRANSMIT ATTENUATOR on test set to position A (–20 dB) and read 27 dBrnc or less.

(i) Turn TRANSMIT ATTENUATOR to position B (–34 dB) and read 19 dBrnc or less.

(j) Disconnect test equipment.

(k) Remove channel bank from loopback mode by pressing LOOP button. LOOP lamp should go out.

(l) Restore slide switch on 91230 unit to NORM.

9.34 Looped Terminal Equipment Test. This test loops the pcm signal, transmit to receive, to verify integrity of hf wiring between the channel bank and the office repeater.

(a) Unplug the 91133 1-for-2 Switching Logic Unit to disable the spare line switching circuits.

(b) Insert one end of a 633A Test Cord (TRS plug on each end) into TRMT EQPT jack on 91112 Office Terminating Repeater Unit associated with channel bank no. 1. (Normally, this will be the repeater in slot 2 of the 91101 Line Terminating Shelf.) Alarm lamps on channel bank will light.

(c) Insert other end of 633A Test Cord into RCV EQPT jack on same repeater.

(d) After about 27 seconds, all alarm lamps on channel bank no. 1 should be out.

NOTE: Failure of alarm lamps to go out indicates incorrect shelf wiring or a malfunctioning equipment unit. As necessary, refer to figure 10-7 for remote terminal assembly wiring diagram and to the troubleshooting procedures in Part 10.

(e) Disconnect test cord from jacks on 91112 unit.

(f) Repeat steps (b) through (e) for channel bank no. 2.

9.35 Conclusion of Testing. When testing is completed, perform the following procedures to make the equipment ready for service and to verify system operation before leaving the remote location.

(a) Reconnect subscriber lines by installing vf protector modules or heat coils, as applicable.

(b) Verify that alignment cord from 91232 Test and Alignment Set is disconnected and that slide switch on 91230 unit of each channel bank is in NORM position.

(c) If simplex loop current is fed from the remote terminal, set current in each 91105 Simplex Power Unit as follows.

(1) Verify that unit is strapped in accordance with transmission engineering recommendations (TER).

(2) Connect multimeter (3-Vdc range) to CUR OUT test points on 91105 unit.

(3) Adjust CUR OUT ADJ control on 91105 unit for multimeter reading of 1.00 volt, or as locally specified. (Multiplying voltage by 100 gives loop current in milliamperes.)

(4) Check that voltage at CUR IN test points is within ±2 percent of voltage at CUR OUT test points.

(d) Verify the battery interconnections as follows.

(1) On power distribution panel, throw MAIN circuit breaker off. Indicator lamps on equipment should not change.

(2) If more than one set of four batteries is used, operate the terminal for a few minutes with only one set connected to the load. The indicator lamps should not change. Repeat this step for each set, in turn.

NOTE: To disconnect a battery set from the load, unplug one end of the jumper between the first and second cells of the set and one end of the jumper between the third and fourth cells of the set.

(3) With all jumpers reconnected, throw the MAIN circuit breaker to on position.

(e) If distant terminals and span lines are operational, check for incoming pulses on each span line by pressing button on 91112 Office Terminating Repeater Unit. Red lamp should light. With button released, if lamp lights continuously or flashes more than once per second, repeatered line is faulty. If a 91112 unit is not equipped with an error detector, check for pulses and errors at the RCV MON jack with a Sierra 314A Error Detecting Set, or equivalent.

(f) If the 91133 1-for-2 Switching Logic Unit (paragraph 9.09) is equipped, install strapping applicable to a remote terminal. (Refer to GTEP Section 342-910-114 for strapping information.)

(g) Plug in the 91133 unit.

(h) The central office terminal should automatically reset the spare line switching equipment, after which all indicator lamps should be out.

9.36 Make a final visual check of the equipment, then close and secure the remote terminal housing.

Initial Office Terminal Alignment

9.37 Initial office terminal alignment is independent and does not require interconnection with another terminal. It does require that the terminal be installed and powered as described in GTEP Sections 342-911-103 and -107 (channel bank) and 342-910-103, -105, and -106 (repeatered line equipment).

9.38 On the 9002A channel bank, Models 1 and 2 of the 91220 Terminal Equipment Shelf are wired for the D2 channel sequence; Model 3 has optional D2 or D3 sequence, but D3 is preferred. On the 9002B channel bank, the 91330 Terminal Equipment Shelf should be arranged for D3 channel sequence. Channel banks at each end of the system must use the same sequence.

9.39 To disable the spare line switching circuits, unplug the 91133 1-for-2 Switching Logic Unit (paragraph 9.09) from its shelf connector.

9.40 Looped Ringing Detection Test. This optional test checks the performance of the signaling channels of 91261, 91263, 91265, and 91269 channel units. The 91267 channel units cannot be tested because of probable signaling incompatibility with the receive channel unit of the looped pair.

9.41 Prepare the channel bank under test as follows.

(a) Loop the channel bank by performing whichever of the following steps is applicable.

(1) If SYSTEM ALARM lamp is on, press ACO button (white ACO lamp should light) and then press LOOP button (green LOOP lamp should light).

(2) If SYSTEM ALARM lamp is off, momentarily insert one end of a suitable test cord into RCV SPAN jack on associated 91112 Office Terminating Repeater Unit. SYSTEM ALARM lamp should light. Press ACO button (white ACO lamp should light) and then press LOOP button (green LOOP lamp should light).

(b) Verify indicator lamps.

Off: REMOTE, LOCAL, POWER
On: SYSTEM ALARM, LOOP, ACO

(c) Set slide switch on 91230 unit to LOOP SIG (or TEST).

9.42 Perform the ringing detection test as follows.

(a) Operate NORM/TEST switches on all 91261, 91263, 91265, and 91269 channel units to NORM.

(b) Connect a current-limited office ringing supply to ring of the CARR 2-WIRE jack on channel unit 1 (transmit) by inserting a properly wired plug into the jack.

NOTE: A locally-fabricated test adapter for deriving the required ringing voltage is shown in figure 9-3.

(c) Verify that red BUSY lamp lights on receive channel unit (2 for D2; 13 for D3).

(d) Unplug ringing supply from transmit channel unit and verify that BUSY lamp on receive channel unit goes out.

(e) Plug ringing supply into CARR 2-WIRE jack on receive channel unit and verify that BUSY lamp on transmit channel unit lights.

(f) Repeat steps (b) through (e) for remaining eleven pairs of channel units. See figure 9-2.

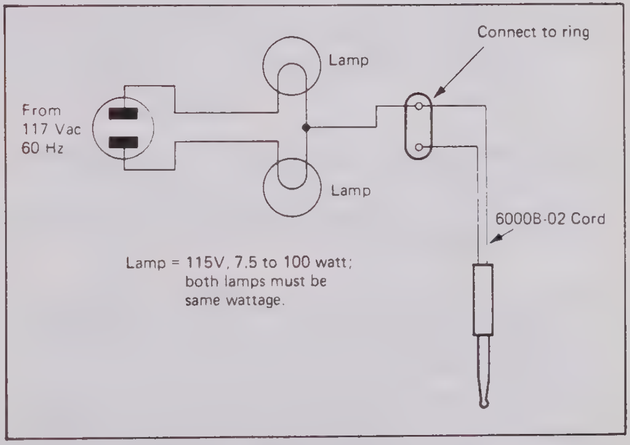
(g) Repeat steps (a) through (f) for next channel bank after it has been prepared for test as in paragraph 9.41.

(h) Disconnect all test equipment from the channel banks.

(i) On both channel banks, press LOOP button. LOOP lamp should go out. After about 15 seconds, all lamps should be out if the transmission line is working.

(j) On 91230 unit of each channel bank, restore slide switch to NORM.

Figure 9-3. Test Adapter to Supply Current-Limited Ringing Voltage



9.43 Looped VF Tests. The descriptions in paragraph 9.24 of optional looped vf tests at the remote terminal are also applicable to the office terminal. On 91261 (Model 1, issue 1 or 2) and 91263 channel units, with the receive level at 0 dBm, channel pairs not under test will sing during the idle channel noise test, causing noise readings to exceed the maximum allowable. Stop the singing by setting the NORM/TEST switches to TEST on all channel pairs not under test. If office connections have been made, this will cause seizure of the corresponding office linefinders.

9.44 Looped Terminal Equipment Test. This test loops the pcm signal, transmit to receive, to verify integrity of hf wiring between the channel bank and the office repeater.

(a) Verify that the 91133 1-for-2 Switching Logic Unit (paragraph 9.09) is unplugged.

(b) Insert one end of a 633A Test Cord (TRS plug on each end) into TRMT EQPT jack of 91112 Office Terminating Repeater Unit associated with channel bank no. 1. (Normally, this will be the repeater in slot 2 of the 91101 Line Terminating Shelf.) Alarm lamps on channel bank will light.

(c) Insert other end of test cord into RCV EQPT jack on same repeater.

(d) After about 27 seconds, all alarm lamps on channel bank no. 1 should be out.

NOTE: Failure of alarm lamps to go out indicates incorrect shelf wiring or a malfunctioning equipment unit. Refer to troubleshooting procedures in Part 10.

(e) Disconnect test cord from jacks on 91112 repeater.

(f) Repeat steps (b) through (e) for channel bank no. 2.

9.45 Auxiliary Alarm Test. With the pcm signals looped back at the line terminating shelf, this test verifies correct operation of the auxiliary alarm channels in the office terminal equipment. Alarm indications are transmitted in parallel over the B signaling path in channels 1 through 6 of both channel banks. At least one of each pair of these channel slots must be equipped with a 91261, 91263, or 91269 channel unit. The 91265 channel unit has auxiliary alarm capability but not in this looped back setup. The 91267, foreign-exchange, dial pulse, and E&M channel units do not have the auxiliary alarm function.

9.46 The following procedure is typical for a remote terminal in a 910A housing assembly. Other auxiliary alarm assignments are tested in a similar way.

(a) Verify that 91133 1-for-2 Switching Logic Unit (paragraph 9.09) is unplugged.

(b) On the 91112 Office Terminating Repeater Units of system 1 and system 2, connect TRMT EQPT jack to RCV EQPT jack with a 633A Test Cord (TRS plug on each end).

(c) After a delay, all channel bank and office alarms should be off.

(d) Verify that NORM/TEST switch on each channel unit is in NORM position.

(e) ALARM MEMORY lamp on 91275 Auxiliary Alarm Panel may light. If it does, press MEMORY RESET button.

(f) On channel bank no. 1, operate NORM/TEST switch on channel unit 1 to TEST. Red BUSY lamp on channel unit 1 should light. ALARM MEMORY and ACTIVE ALARM lamps on 91275 panel should be lighted. Office alarms should be activated.

(g) Press ACO switch on 91275 panel. White ACO lamp on 91275 panel should light and office alarms should be cut off.

(h) Press DOOR OPEN button on 91275 panel. ALARM MEMORY lamp should remain lighted.

(i) One at a time, press other alarm function buttons on 91275 panel (AC FAIL, BAT. LOW, TEMP HIGH, RING SUPPLY, FUSE/ALARM). As each is pressed, ALARM MEMORY lamp should go out.

(j) Return NORM/TEST switch on channel unit 1 to NORM. BUSY lamp on channel unit 1 should go out. ACTIVE ALARM lamp should go out and ALARM MEMORY lamp should stay lighted.

(k) Press MEMORY RESET button. ALARM MEMORY lamp must go out.

(l) On channel bank no. 1, operate NORM/TEST switch on channel unit 2 to TEST. Red BUSY lamp on channel unit 2 should light. ALARM MEMORY and ACTIVE ALARM lamps on 91275 panel should be lighted. Office alarms should be activated.

(m) Press ACO button on 91275 panel. White ACO lamp should light and office alarms should be cut off.

(n) Press AC FAIL button on 91275 panel. ALARM MEMORY lamp should remain lighted.

(o) One at a time, press remaining alarm function buttons. As each is pressed, ALARM MEMORY lamp should go out.

(p) Return NORM/TEST switch on channel unit 2 to NORM. BUSY lamp on channel unit and ACTIVE ALARM lamp should go out.

(q) Press MEMORY RESET button. ALARM MEMORY lamp should go out.

(r) Repeat steps (f) through (q) for the remaining channel units of channel bank no. 1 that are equipped with auxiliary alarm inputs (channels 3, 4, 5, and 6), taking into account that the appropriate alarm function buttons will change depending on which channel units are being tested. See figure 9-4.

(s) Repeat steps (f) through (r) for channel bank no. 2.

(t) At the conclusion of the auxiliary alarm tests, return the terminals to their normal condition by removing test cords from both 91112 repeater units. After a delay of about 27 seconds, all alarms should be off if repeatered lines and remote terminal are operational.

(u) Press MEMORY RESET button. ALARM MEMORY lamp should go out.

Figure 9-4. Auxiliary Alarm Channel Assignments

	Transmitted Over Channel	
Alarm Function	Channel Bank No. 1	Channel Bank No. 2
DOOR OPEN	1	1
AC FAIL	2	2
BAT. LOW	3	3
TEMP HIGH	4	4
RING SUPPLY	5	5
FUSE/ALARM	6	6

Repeatered Line and Spare Line Switching Tests

9.47 These tests are made at the central office to verify satisfactory operation of the repeatered line in both directions and the spare line switching equipment at both terminals.

▶9.48 Before testing the repeatered line, set or check the simplex loop current in each 91105 Simplex Power or 91125 Simplex Power Converter Unit as follows:◀

(a) Verify that unit is strapped in accordance with transmission engineering recommendations (TER).

▶(b) Connect multimeter (3-Vdc range) to CUR OUT test points on the 91105 or 91125 unit.◀

(c) Adjust CUR OUT ADJ control on 91105 unit for multimeter reading of 1.00 volt, or as locally specified. (Multiplying voltage by 100 gives loop current in milliamperes.) The 91125-01 current is ▶automatically regulated to 60 ±3mA; the -02 to 60 ±3mA or 100 ±5mA.◀

(d) Check that voltage at CUR IN test points is within ±2 percent of voltage at CUR OUT test points.

9.49 With span lines and channel banks checked out, all indicator lamps on the equipment should be out. If the channel bank LOOP lamp is lighted, push the LOOP button to the out position.

9.50 Spare line switching of system 1 and system 2 may be controlled by the system alarm of the channel bank (terminal-alarm switching) or by the error detector on the 91112 repeater units (repeater-alarm switching). When terminal-alarm switching is used, do not try reset the 91133 unit (TR RESET button) until the SYSTEM ALARM lamp on the applicable channel bank is out. Doing so will delay restoral because each time the TR RESET button is pushed, a new restoral cycle that takes as long as 30 seconds may be initiated.

9.51 Plug in the 91133 1-for-2 Switching Logic Unit (paragraph 9.09). IF necessary, push the TR RESET button. If the 91133 (or 91122) unit is Model 1, push the SP L RESET button to restore the transfer equipment to normal. If the unit is Model 2, reset is automatic. If the repeatered lines do not respond to the reset procedures, refer to the 9101C repeatered line troubleshooting procedures in Section 342-910-103.

9.52 Spare Line Switching Test. The following procedure tests spare line switching and checks the repeatered lines for pulses and errors. If a 91112 repeater unit is not equipped with an error detector, use a Sierra 314A Error Detecting Set, or equivalent, to check for pulses or errors at the RCV MON jack on the 91112 unit.

(a) Check for incoming pulses by pressing button on each 91112 Office Terminating Repeater Unit, in turn. Red lamp should light. With button released, if lamp lights continuously or flashes more than once per second, repeatered line is faulty.

NOTE: If remote fault locating is provided, the preceding step verifies performance of the spare line in both directions.

(b) Fail spare line by terminating transmit signal. This is done by inserting a 665B Plug (100-ohm termination) in the TRMT EQPT jack of the 91112 repeater unit for the spare line.

(c) Press button on 91112 repeater unit for spare line. Red lamp should not light, indicating that spare line has failed.

(d) On the 91133 1-for-2 Switching Logic Unit, SP L ALM lamp should be on. On the 91103 Fuse and Alarm Unit, FUSE ALARM lamp should be on. Office alarms should be activated as well.

(e) Operate ACO switch on 91133 unit. White ACO lamp should light and office alarms should be cut off.

(f) Reset spare line by removing 665B plug. After about 10 seconds, SP L ALM lamp should go out.

(g) Fail line 1 by momentarily inserting a 665B Plug (100-ohm termination) in TRMT SPAN jack of line 1 repeater. TR1 lamp on 91133 unit should light.

NOTE: The action of step (g) will cause a line transfer. If remote fault locating is provided, line 1 will be looped back at the remote end. In this mode, both directions of the line can be checked.

(h) While pressing TEST button on 91133 unit, press button on 91112 repeater unit for line 1. Red lamp should light continuously when button on 91112 unit is in. Lamp should remain out when button is released.

(i) Reset lines by pressing TR RESET button on 91133 unit.

(j) Repeat steps (g) through (i) for line 2. TR2 lamp on 91133 unit should light.

Remote-Looped Transmission Test

9.53 As part of the initial alignment of the 910A system, at the central office check the performance of each channel using the following remote-looped transmission tests in paragraphs 10.15 through 10.18.

(a) Functional Channel Operation
(b) Channel Net Loss
(c) Idle Channnel Noise
(d) Signaling Bias Distortion (optional)

The first three tests listed above are mandatory for the initial system alignment; the last three are optional for routine maintenance.

10. MAINTENANCE

10.01 Special maintenance procedures for the 910A system are outlined in figure 10-1. Also, refer to the procedures in GTEP Sections 342-911-103 and -107 (channel bank) and 342-910-103, -105, and -106 (repeatered line equipment).

Circuit Diagrams

10.02 Circuit diagrams of the 91275 Auxiliary Alarm Panel, the 91270 Equipment Shelf, and subscriber-type and office-type channel units are in Parts 3 and 4 of this Section. For other plug-in units used in the 910A system, refer to GTEP Sections 342-911-103 and -107 (channel bank) and 342-910-103, -105, and -106 (repeatered line equipment). Circuit diagrams and wiring diagrams applicable to the terminals are listed below.

(a) Office Installation. Refer to the GTEP Sections cited above for a CO Terminal or a remote terminal installation in an office or customer-furnished shelter. Also, see figure 10-3 (auxiliary alarms), figure 10-4 (channel units), and figure 10-5 (91270-01 shelf, if applicable).

(b) Remote Terminal Office Installation. Figure 10-6 shows hf and power distribution circuits of a typical remote terminal with two channel banks and spare line switching controlled by error detectors on the 91112-02 repeater units. A 91270-01 shelf is equipped

Figure 10-1. Special Maintenance Procedures for 910A System

Procedure	Paragraph
Replacement or addition of channel units	10.11
Routine remote-looped transmission tests (at central office)	10.14
Functional channel operation	10.15
Channel net loss	10.16
Idle channel noise	10.17
Signaling bias distortion	10.18
Full-prepay channel unit signaling tests	
Coin box trunk test set	10.19
Automatic coin test line	10.22
WECo coin station test line	10.23
Semi-postpay channel unit signaling tests	10.27
Ringing test	10.26
Channel unit adjustments	10.27
Receive level (using 91232 test set)	10.28
Receive level (using milliwatt supply)	10.32
Transmit gain	10.33
Optional end-to-end tests	10.34
Idle channel noise	
Distortion	
Frequency response	
Crosstalk	
Impulse noise	
Dial pulse signaling distortion	
Simplex loop current	10.36
Replacement of air filters	10.37

with a 91271 unit for power distribution and a 91272 unit for coin control and ringing voltage supplies. Span power, if required, is obtained from office batteries.

(c) 910A Remote Terminal Housing Assembly. Complete circuit diagrams of the housing assembly are shown in figure 10-7. Circuit modifications for special applications are described in figures 10-8 through 10-11.

Controls and Indicators

10.03 At the CO terminal, indicator lamps on the equipment are normally not lighted. The functions of operating controls and the meanings of lighted indicator lamps are described in following paragraphs.

10.04 Channel Bank. Controls and indicators, except the NORM/TEST switch and BUSY lamp on the CO channel units, are on the 91230 Alarm and Control Units.

(a) Side switch: Must be in NORM position except as required for testing or troubleshooting. The 91230 Model 3 switch has three positions: TMB HOLD, NORM, and LOOP SIG. On 91230 Models 1 and 2 switch is called LOOP SIG and has two positions: NORM and TEST.

(b) SYSTEM ALARM lamp (yellow): Indicates system alarm initiated by a local, power, or remote alarm, and maintained by an operated ACO relay or LT (loop test) relay.

(c) LOOP button and lamp: In a system alarm condition, pressing the LOOP button conditions the channel bank for loop testing as follows: loops hf transmit to hf receive, but transmits continuous 1's to hf line; alters timing so that each channel transmits to and receives from another channel (figure 9-2). Green LOOP lamp indicates the channel bank is in loop test mode.

(d) ACO button and lamp: In a system alarm condition, silences external audible alarms. ACO lamp indicates ACO relay is operated.

(e) REMOTE alarm lamp (yellow): Indicates that the remote terminal has detected a failure in the transmission being received from the local terminal. Remote alarm is inhibited by a local alarm that occurs prior to or simultaneously with the remote alarm.

(f) LOCAL alarm lamp (red): Indicates that the local terminal has detected a failure in the transmission being received from the remote terminal, or that the remote terminal is in loop test mode.

(g) POWER alarm lamp (red): Indicates a blown fuse on the 91235 Power Supply Unit or failure of any of the three dc voltages (+5V, +12V, and −12V) from the 91235 unit.

(h) NORM/TEST switch on CO channel unit: In TEST position, conditions channel for remote-looped testing.

(i) BUSY lamp on CO channel unit: Indicates P relay is operated. (P relay is operated while channel is busy and follows incoming dial pulses.)

10.05 Auxiliary Alarm Panel. The alarm states of six functions in the remote terminal can be determined from indications on the 91275 Auxiliary Alarm Panel. Normally, all indicators are out. Proceed as follows when the ALARM MEMORY lamp or an ACTIVE ALARM lamp is lighted. (Model 1 of the 91275 panel has only one ACTIVE ALARM lamp; Model 2 has two: MINOR and MAJOR.)

(a) Push the ACO button. Office alarms will shut off and ACO lamp will light.

(b) When lighted, the ALARM MEMORY lamp indicates that one or more functions were previously in alarm or are presently in alarm. If an ACTIVE ALARM lamp is also lighted, then one or more functions are presently in alarm. To identify the functions, push the six alarm buttons, one at a time. If the function has a previous or present alarm, the ALARM MEMORY lamp will stay lighted. Otherwise, the lamp will go out.

(c) Having identified functions in alarm, push the MEMORY RESET button. If there are no active alarms, the ALARM MEMORY lamp will go out.

(d) To verify the condition of the indicator lamps, push the LAMP CHECK button. All lamps should light.

10.06 91103 Fuse and Alarm Unit.

(a) FUSE ALM lamp (red): Indicates a blown fuse on the 91103 or 91105 units. The alarm circuit controlling the FUSE ALM lamp also controls office alarms. The alarm circuit is also activated by the 91133 unit when the error detector on a 91133 unit when the error detector on a 91112 repeater unit has responded to a failure or high error rate on an incoming signal; this control of the 91103 alarm circuit is disconnected when the ACO switch on the 91133 unit is in cutoff position.

10.07 91112 Office Terminating Repeater Unit.

(a) PULSES/ERRORS button and lamp (red): With button released, lamp should be out or flash not more frequently than once per second. When button is pushed, lamp should light, indicating presence of incoming pulses.

10.08 91133 1-for-2 Switching Logic Unit.

(a) TR lamp (red) if equipped: Indicates working system has transferred to spare line.

(b) TR1 and TR2 (light-emitting diodes): Indicates system 1 (TR1) or system 2 (TR2) has transferred to spare line.

(c) SP L ALM lamp (red): Indicates failure of spare line.

(d) ACO lamp: Indicates ACO switch is in cutoff position.

(e) ACO switch: In cutoff position, disconnects alarm circuit to the 91103 unit.

(f) TR RESET pushbutton (non-locking): Resets switching circuits after a failure on a working system has been corrected.

(g) TEST pushbutton (non-locking): In a system with the spare line looped at the remote terminal, pushing the TEST button at the local terminal applies a driving signal to the previously failed line to check its condition before resetting.

10.09 91120 Spare Line Transfer Shelf. Controls and indicators on the 91121 Switching Logic Unit (TR1, TR2, and TR3 light-emitting diodes) and the 91122 Spare Line Logic Unit (TR and SP L ALM lamps; TR RESET and TEST switches) are equivalent to those on the 91133 unit described in the preceding paragraph.

10.10 These additional controls and indicators are at the left side of the shelf.

(a) ALM lamp (red): Indicates a blown fuse or a transfer.

(b) ACO switch and lamp: In cutoff position, switch shuts off audible office alarm. ACO lamp indicates switch is in cutoff position.

Replacement or Addition of Channel Units

10.11 In an operating system, when channel units are replaced or added, channel performance should be checked by the applicable remote-looped transmission test beginning at paragraph 10.14. Additional end-to-end signaling tests for paystation channel units and ringing tests for all channel units are in paragraphs 10.19 through 10.26.

10.12 Before installing a 91260, 91262, or 91269 Channel Unit, verify strapping as specified on the channel unit circuit diagram in Part 4. With the full-prepay channel units, check that the applicable subassemblies are installed on the 91266 unit and that the 91267 unit has complementary strapping.

10.13 Channel units are adjusted at the factory for a receive level of 0 dBm ± 0.5 dB. If a different level in the 0 to − 3 dBm range is required, or if the accuracy of the level setting is uncertain, adjust receive level and transmit level as described in paragraphs 10.27 through 10.33.

WARNING: At the remote terminal, high ringing voltage (− 260V or − 310V) can be encountered on the exposed printed circuit of subscriber channel units. Be careful when installing or removing these units or working on the subscriber loop wiring. When a unit is removed, wait a few seconds for ringing circuit capacitors to discharge before you touch any circuit traces.

In addition, you must take extra precautions to prevent equipment damage. Shorting or grounding the ringing supply voltage on a channel unit can cause total failure of that unit and possibly many other units. If the condition is prolonged, printed circuit boards may overheat and char.

(a) Do not used unoccupied channel unit mounting positions in the shelf as a resting place for tools, test equipment, or material.

(b) Before you insert a unit, inspect unit and mating shelf connector for foreign material, such as wire clippings.

(c) Keep channel units dry.

Routine Remote-Looped Transmission Tests

10.14 Individual channel performance should be checked on a routine basis by remote-looped transmission tests at the central office. In these tests, the vf and "A" signaling paths of subscriber-type channel units are looped back at the remote terminal upon command from the central office terminal. Four types of tests are listed below: the last three are optional.

(a) Functional Channel Operation
(b) Channel Net Loss
(c) Idle Channel Noise
(d) Signaling Bias Distortion

10.15 Functional Channel Operation. Remote-looped channel vf and signaling (but not ringing) can be checked from the CO terminal using a hand test telephone (butt-in), such as GTE Automatic Electric type 801, and a 91276 Pulsing/VF Test Adapter. The channel units must be cross-connected to the CO equipment.

(a) Connect test adapter to ALIGN receptacle on 91230 Carrier Group Alarm and Control Unit of channel bank.

CAUTION: Battery is now present on the TEST PHONE jacks of the test adapters. Contact with ground will blow the fuse on the 91230 unit.

(b) Plug test adapter into XMT SIG and GRD pin jacks and RCV MON and GRD pin jacks on channel unit to be tested.

(c) Set switch on butt-in to monitor position, and connect butt-in to TEST PHONE jack.

(d) On channel unit, if BUSY lamp is not lighted, throw NORM/TEST switch to TEST to loop back vf and signaling at remote terminal.

(e) Set switch on butt-in to center position (off-hook). BUSY lamp should light.

(f) If C-lead connection to office equipment is used, C-lead is grounded in the test mode of the channel unit and dial tone may not be heard. Dialing with the butt-in will pulse the BUSY lamp but may not break dial tone.

(g) If C-lead connection is not used, dial tone should be present. Dial a CO test number. Test tone, busy tone, or voice must be heard, verifying vf transmission in both directions. If not, replace CO channel unit. If trouble does not clear, replace remote channel unit.

(h) Unplug test adapter from channel unit.

(i) Repeat steps (b) through (h) for other channels to be tested.

10.16 Channel Net Loss. In this test at the CO terminal, 0-dBm test tone from the 91232 Test and Alignment Set is transmitted over the channel to the remote terminal and there looped back. The level of the signal returned to the CO is measured on an acvm at a 600-ohm point in the four-wire receive branch of the channel unit.

(a) Prepare the 91232 Test and Alignment Set for operation (paragraph 9.18).

(b) On the 91232 test set, turn TRANSMIT ATTENUATOR switch to 0 dB. Push in CHANNEL TYPE SELECT buttons 2W 900Ω (■) TRANSMIT and 2W 600Ω (▲) RECEIVE.

(c) Connect an unterminated 600-ohm acvm to MEASURE LEVEL jack on test set witha 6100B-02 Test Cord (TRS-TT plug to GR plug).

(d) On channel unit to be tested, if BUSY lamp is not lighted, throw NORM/TEST switch to TEST.

(e) With a 6100C-02 Patch Cord (TRS-TT plug on each end), connect TRANSMIT jack on test set to CARR 2-WIRE jack on channel unit.

(f) With a 729B Test Cord (TRS-TT plug to twin pin plug), connect RECEIVE jack on test set to RCV MON and GRD pin jacks on channel unit.

(g) Reading on acvm should equal sum of net loss in each direction of transmission with a tolerance of ± 0.6 dB. For example, if the receive level at each end has been adjusted to − 2 dBm using a 0-dBm transmit level (2-dB net loss), the acvm should read − 4 dBm ± 0.6 dB. If the channel units were installed with the factory-adjusted net loss of 0 dB ± 0.5 dB, the acvm should read 0 dBm ± 1.0 dB.

(h) If the reading in the preceding step was more than ± 2 dB from nominal, try replacing the CO channel unit first, and then the remote channel unit. If the reading, was less than 2 dB from nominal, readjust channel net loss; see paragraph 10.27.

(i) Restore NORM/TEST switch to NORM and disconnect test cords.

10.17 Idle Channel Noise. In this test at the CO terminal, the vf path is looped back at the remote terminal and idle noise is measured at a 600-ohm, + 3.5-dBm point in the four-wire receive branch of the channel unit.

(a) Set controls on noise measuring set as follows: INPUT to 600Ω TERM, HOLD to OFF, and FILTER to C MSG.

(b) Insert a 6000A-02 Plug (900-ohm termination) in CARR 2-WIRE jack on channel unit.

(c) Throw NORM/TEST switch in channel unit to TEST.

(d) With a 729A Test Cord (TRS plug to twin pin plug), connect noise measuring set to RCV MON and GRD pin jacks. Case of noise measuring set must be connected to channel bank ground.

(e) Noise measuring set should read 27 dBrnc or less (for 0-dBm receive level).

(f) If meter reads more than 27 dBrnc, replace CO channel unit. If noise level is still high, disconnect subscriber loop at remote terminal and repeat noise measurement at CO terminal. Replace remote channel unit if noise level exceeds 27 dBrnc.

10.18 Signaling Bias Distortion. In this test at the CO terminal, the 26600 Signaling Test Set is used to remotely pulse the A signaling path of the subscriber-end channel unit and to measure returned pulses at the two-wire jack.

(a) Prepare the 26600 Signaling Test Set to transmit pulses at 10 pps and 60 percent break. (See Section 108-402-504 for Model 1 test set and 108-402-106 for Model 2.)

(b) On E&M side of signaling test set, turn M key to B/G and set PULSE key to LINE. On LOOP side, set INCOMING key to MEASURE.

(c) On channel unit to be tested, if BUSY lamp is not lighted, throw NORM/TEST switch to TEST.

(d) With 6100D-02 Patch Cord (TRS plug to TRS-TT plug) connect IN jack on LOOP side of signaling test set to CARR 2-WIRE jack on channel unit.

(e) With a 729A Test Cord (TRS plug to twin pin plug), connect LINE jack on E&M side of signaling test set to XMT SIG and GRD pin jacks on channel unit. Bar side of twin pin plug must go to GRD jack.

(f) Signaling test set should read between 60 percent and 68 percent break. If not, replace remote channel unit.

(g) Restore NORM/TEST switch to NORM and disconnect test cords.

Full-Prepay Channel Unit Signaling Tests

10.19 Coin Box Trunk Test Set. The following procedure checks certain signaling functions of full-prepay channel units pairs, 91266 and 91267, before connection to the paystation. The paystation is simulated by a WTS-620 Coin Box Trunk Test Set and an 801 Hand Test Telephone (butt-in), or equivalent. Similar tests using other test equipment and automatic coin test lines may not produce satisfactory results.

(a) At the central office terminal, connect two-wire drop from 91267 channel unit to applicable office paystation line. Be sure to maintain standard tip/ring relationship required for paystations (battery on ring).

(b) Set NORM/TEST switch on 91267 channel unit to NORM.

(c) At the remote terminal, connect WTS-620 test set to subscriber loop at protector block or other convenient access external to 91266 channel unit; do not use channel unit test points. Observe color code of test leads: green to tip, red to ring, and black to ground.

(d) Connect butt-in to T and R binding posts, T-R jack, or 1011B jack on test set.

(e) On the test set, set coin-ground switch to 1500Ω and TEST/TALK switch to TALK (no coin ground).

(f) Seize paystation line with butt-in. For the two optional dash numbers of the 91266 unit, sidetone (indicating presence of talk battery) and dial tone should be heard as follows: -01, sidetone and maybe dial tone; -03, neither.

(g) Operating the butt-in dial should not break dial tone with the -01 option (if dial tone is present).

(h) Set TEST/TALK switch to TEST. This connects COLLECT lamp, RETURN lamp, and a 1500-ohm resistor (coin ground) between tip of pair and ground.

NOTE: In the following sequence with the -03 option, allow at least 2 seconds after each call for the channel unit to switch from loop operation (side-tone present) back to tip open (no sidetone). Otherwise, supervision wil be erratic.

(i) Dial a noncharge number. After answer, release connection. RETURN lamp should light repeatedly indicating coin-return supervision.

NOTE: If lamp does not light, check for +130V and −130V on TB1 of channel bank.

(j) Set TEST/TALK switch to TALK to remove coin ground.

(k) After at least 10 seconds, seize paystation line with butt-in and then set TEST/TALK switch to TEST to apply coin ground.

(l) Dial a charge number. After answer, at a time determined by office equipment (usually within 15 seconds or upon disconnect). COLLECT lamp should light repeatedly indicating coin-collect supervision.

NOTE: Some office equipment requires at least 15 seconds off-hook to switch from the return to the collect mode supervision.

(m) Release connection with butt-in.

(n) Set TEST/TALK switch to TALK to remove coin ground.

(o) Return to step (f) and repeat procedure several times to ensure that results are consistent.

(p) If tests are OK, remove test equipment and connect paystation to line. If a WTS-620 test set is not available, testing can be accomplished using a paystation in place of the WTS-620.

10.20 If the required results are not obtained in the test procedure above, perform the same procedure at the office to determine whether trouble is in the carrier channel or the office equipment and cross-connect. Test connections should be made on the 91267 channel unit. After inserting an open plug in the CARR 2-WIRE jack, connect the WTS-620 test leads to pin jacks as follows: green to upper 2W MON (tip), red to lower 2W MON (ring), and black to GRD.

10.21 If the test at the office is OK, trouble is in the carrier channel. Replace the 91267 channel unit and repeat the procedure at the remote terminal. If the test fails, replace the 91266 channel unit. If the test still fails, and the channel is know to be good with a pair of channel units of different type, the problem may be incompatibility between channel units and office paystation trunk equipment.

10.22 Automatic Coin Test Line. The procedures of paragraph 10.19 verify seizure, coin present, coin collect, and coin return supervision only. After the paystation is installed, further tests with an automatic coin test line may be made. Test lines are designed to test paystations over physical loops. When the loop includes a carrier-derived channel, the carrier equipment will not be able to reproduce all of the test conditions that it receives. For example, ground resistance, loop resistance, and leakage are simulated by the 91267 unit. Coin control relay timing tests will indicate significant additional delay through the carrier. Where incompatibility exists, testing at the paystation may have to be limited to basic coin supervision or the procedures used with the test line revised.

10.23 WECo J93025A/SD-1C297 Coin Station Test Line. With the carrier channel in good operating condition, coin function testing and gauging with the WECo equipment should not be affected by the presence of the carrier channel in the paystation loop. However, in resistance tests with this automatic equipment, the real parameters of the physical loop at the remote terminal are masked by the carrier channel. The test line will "see" only the office wiring and the two-wire input circuits in the 91267 office channel unit. Results of the tests should be as follows.

(a) Ground resistance. The 1,000 ohms resistance in the 91267 channel unit may result in a test line indication of "ground resistance too high."

(b) Loop resistance. The 600 ohms loop resistance in the channel unit should be accepted by the test line.

(c) Loop leakage. The loop leakage test should be OK.

10.24 In the carrier channel, coin collect/return commands to the remote terminal are delayed about 70 miliseconds; coin absent/present indications returning to the central office terminal are delayed about 10 milliseconds. Consequently, in the coin relay timing test, a high out-of-limits indication received at the paystation from the test line should be disregarded.

Semi-Postpay Channel Unit Signaling Tests

10.25 The following procedure at the remote terminal checks for reverse battery supervision on the 91268 channel unit. An 801 Hand Test Telephone (butt-in), or equivalent, and a multimeter are required.

(a) At the central office, connect two-wire drop from 91269 channel unit to assigned paystation line.

(b) At the remote terminal, connect butt-in to 2W MON pin jacks or CARR 2-WIRE telephone jack on 91268 channel unit.

(c) Bridge the multimeter (300-Vdc range) across butt-in to indicate talk battery voltage (48 volts).

(d) Dial a collect number.

(e) When called party answers, multimeter should indicate reversal of talk battery voltage.

(f) Disconnect test equipment.

Ringing Test

10.26 With all channel units except 91266, an operational ringing test can be performed at the remote terminal. Connect the order wire PHONE jack to the 2W MON pin jacks on the channel unit with a 729B cord. Dial the applicable ringback number. (The straight-line bridged ringer in the order wire telephone will respond to bridged, divided, or superimposed ringing.) The ringing test for a 91266 channel unit should be made at the paystation because the 2W MON pin jacks on this unit are isolated from the subscriber loop during ringing. Also, note that the 91266-03 unit does not cut through the vf path during the silent interval; it only trips and cuts through during ringing.

Channel Unit Adjustments

10.27 The RCV LEV control on the channel unit is set at the factory for a channel receive level of 0 dBm ±0.5 dB. If necessary, the level can be adjusted between 0 and −3 dBm by the procedure in paragraph 10.28 or 10.32, as applicable. Then, for coordination of levels, the XMT LEV control on the channel unit at the other end of the system should be adjusted using the procedure in paragraph 10.33.

10.28 Channel Receive Level Adjustment Using Test Set. The test tone for this procedure is injected digitally in the receive branch of the common equipment by the 91232 Test and Alignment Set. (For Model 1 of the 91260 and 91262 channel units, use the procedure in paragraph 10.32.) To prevent accidental injection of test tone in channels carrying traffic, it is very important to follow the step-by-step sequence of the procedure.

(a) Turn DIGITAL FUNCTION switch to OFF.

(b) Push the PUSH TO TEST TERMINAL button to its outer position.

(c) Connect alignment cord (furnished with test set) between ALIGN connectors on test set and channel bank to be tested.

(d) If POWER lamp is not lighted, push in POWER ON/OFF switch. (The Model 2 test set does not have a power switch.)

(e) Turn DIGITAL FUNCTION switch to 1 kHz on END/END side of switch.

(f) Push 1 kHz CHECK button. Green lamp should light.

10.29 If an acvm is to be used for level readings, prepare it for 600-ohm bridging measurements and connect it to the MEASURE LEVEL jack on the test set. (Ring and sleeve contacts of this jack are grounded.) If the TTS-37B noise measuring set is to be used for level readings, prepare it for operation as follows.

CAUTION: When the 91232 test set supplies operating power to external test equipment from its −48V OUT jack, the test set end of the power cable should be connected last and disconnected first to prevent blowing the fuse on the 91230 Alarm and Control Unit.

(a) Connect a 725A Test Cord (power cable with TRS plug on each end), between 48V jack on TTS-37B and −48V OUT jack on test set.

(b) Connect a 6100B-02 Test Cord (TRS-TT plug to GR plug) between LINE jack on TTS-37B and MEASURE LEVEL jack on test set.

(c) Set switches on TTS-37B as follows: POWER to ON, INPUT to 600Ω BRDG, HOLD to OFF, FILTER to 3KC, and SENS to 0 dBm.

NOTE: Continue the procedure at paragraph 10.30 or 10.31 as applicable.

10.30 For subscriber-end channel units:

(a) On the test set, push in RECEIVE CHANNEL TYPE SELECT button 2W 900Ω (■).

▶(b) Set CHANNEL POSITION switch to applicable channel number as listed in figure 10-2.◀

(c) With a 6100C-02 Patch Cord (TRS-TT plug on each end), connect RECEIVE jack on test set to CARR 2-WIRE jack on channel unit. If the channel unit is 91266, instead connect to the 2W MON pin jacks using a 729B Test Cord (TRS plug to twin pin plug).

(d) Push in the PUSH TO TEST TERMINAL button. Green lamp must light.

(e) Adjust RCV LEV control on channel unit for required level between 0 and −3 dBm.

(f) Push out the PUSH TO TEST TERMINAL button. Green lamp must go out.

NOTE: If the transmit gain of the associated office channel unit is to be adjusted, refer to paragraph 10.33.

(g) Unplug patch cord from channel unit.

(h) To adjust other channels, return to step (b).

10.31 For office-end channel units:

(a) On the test set, push in RECEIVE CHANNEL TYPE SELECT button 4W 600Ω (●).

▶(b) Set CHANNEL POSITION switch to applicable channel number as listed in figure 10-2.◀

(c) With a 729B Test Cord (TRS-TT plug to twin pin plug), connect RECEIVE jack on test set to RCV MON and GRD pin jacks on channel unit.

(d) Throw NORM/TEST switch on channel unit to TEST.

(e) Push in the PUSH TO TEST TERMINAL button on test set. Green lamp must light.

(f) Adjust RCV LEV control on channel unit for required level between +4.2 and +1.2 dBm. This range corresponds to levels between 0 and −3 dBm at the two-wire office interface.

(g) Push out the PUSH TO TEST TERMINAL button. Green lamp must go out.

NOTE: If the transmit gain of the associated subscriber channel unit is to be adjusted, refer to paragraph 10.33.

(h) Restore NORM/TEST switch on channel unit to NORM.

(i) Unplug cord from channel unit.

(j) To adjust receive level of other channels, return to step (b).

Figure 10-2. Thumbwheel Switch Settings on 91232 Test Set for D3 and D2 Channel Sampling Sequences

Channel Under Test	91232-01 or -02		*91232-03 or -04	
	D2	D3	D3	D2
	Set CHANNEL POSITION Switches to			
1	01	12	01	03
2	02	13	02	15
3	03	01	03	09
4	04	17	04	21
5	05	05	05	05
6	06	21	06	17
7	07	09	07	11
8	08	15	08	23
9	09	03	09	07
10	10	19	10	19
11	11	07	11	13
12	12	23	12	01
13	13	11	13	02
14	14	14	14	14
15	15	02	15	08
16	16	18	16	20
17	17	06	17	04
18	18	22	18	16
19	19	10	19	10
20	20	16	20	22
21	21	04	21	06
22	22	20	22	18
23	23	08	23	12
24	24	24	24	24

*Also 91232-01 or -02 modified per MK3.

10.32 Channel Receive Level Adjustment Using Office Milliwatt Supply. This procedure adjusts the receive level of a subscriber-end channel unit using a dialed-up test tone from the office milliwatt supply. It is intended only for these channel units: 91260 Model 1, 91262 Model 1, and 91266. A TTS-37B noise measuring set and a hand test telephone (butt-in) are required.

(a) Connect a 725A Test Cord (power cable with TRS plug on each end) between 48V jack on TTS-37B noise measuring set and −48V jack on 91271 Fuse and Alarm Unit, if used, or to another 48-volt supply jack on the equipment.

(b) Set switches on TTS-37B as follows: POWER to ON, FILTER to 3KC, and SENS to 0 dBm.

(c) Connect butt-in to DIAL jack on TTS-37B.

(d) To prevent double termination, disconnect subscriber loop by pulling vf protector module out to first notch or by pulling heat coils, as applicable.

(e) On TTS-37B, turn INPUT switch to DIAL AND TALK and set HOLD switch to OFF.

(f) Connect LINE jack on TTS-37B to 2W MON pin jacks on channel unit.

(g) If required, momentarily ground ring side of paystation line to get dial tone.

(h) Dial number of office milliwatt supply.

(i) When test tone is received, set HOLD switch to ON.

(j) Turn INPUT switch to 900Ω TERM.

(k) Adjust RCV LEV control on channel unit for required level between 0 and −3 dBm.

(l) Unplug test cord from channel unit.

(m) Reconnect subscriber loop.

(n) To test other channel units return to step (d).

10.33 Channel Unit Transmit Gain Adjustment. The XMT LEV control on the channel unit has a ± 1 dB adjustment range and is factory-set to compensate for production tolerances in the transmit gate circuit. If required, adjust the transmit gain with the XMT LEV control just after setting the receive level at the other end of the system (paragraph 10.28 or 10.32). With one person at each location, proceed as follows:

(a) At transmit end, apply a 0-dBm test tone to two-wire vf interface of channel unit using 91232 test set or a separate oscillator as a signal source.

NOTE: On the 91232 test set at the receive end, the green lamp above the PUSH TO TEST TERMINAL button must be out, indicating that the digital milliwatt source is turned off.

(b) While reading test tone level at receive end, adjust XMT LEV control at transmit end for same reading previously set with RCV LEV control.

Optional End-to-End Tests

10.34 The following single-channel end-to-end tests are not required as acceptance tests or for routine maintenance but may be useful in troubleshooting.

(a) Idle Channel Noise Test
(b) Distortion Measurement
(c) Frequency Response Test
(d) Crosstalk Test
(e) Impulse Noise Test
(f) Dial Pulse Signaling Distortion Test

10.35 Use the test procedures and performance requirements in GTEP Sections 342-911-103 and -107 with the following modifications and additions.

(a) Two 91232 Test and Alignment Sets are required, one at each terminal. Use 2W 900Ω (■) position of CHANNEL TYPE SELECT switches.

(b) Connect the 91232 test set to the CARR 2-WIRE jack on the channel unit with a 6100C-02 Patch Cord (TRS-TT plug on each end).

(c) If the channel unit at the remote terminal does not have a CARR 2-WIRE jack, connect the 91232 test set to the 2W MON pin jacks with a 729B Test Cord (TRS-TT plug to twin pin plug). Disconnect the subscriber loop by pulling the vf protector module out to the first notch (remote housing) or by pulling the heat coil (remote office), as applicable.

(d) At the CO terminal, the NORM/TEST switch on the channel unit must be in NORM position for all end-to-end tests.

(e) In the dial pulse signaling distortion test at the CO terminal, connect the LP IN jack on the 26600 test set to the CARR 2-WIRE jack on the channel unit with a 6100D-02 Test Cord (TRS plug to TRS TT plug).

(f) In the dial pulse signaling distortion test at the remote terminal, connect the LP OUT jack on the 26600 test set to the CARR 2-WIRE jack on the channel unit. If the channel unit does not have a CARR

2-WIRE jack, disconnect the subscriber loop and connect the LP OUT jack to the 2W MON pin jacks with a 729A Cord (TRS plug to twin pin plug).

(g) Requirements for dial pulse signaling distortion test (except for 91266-03):

Pulse 12 pps at 60% break	Measure
Leak A	57% break minimum
Loop, 0 to 1600 ohms	72% break maximum

(h) Requirements for dial pulse signaling distortion test of 91266-03 channel unit:

Pulse 12 pps at 60% break	Measure
Leak A	54% break minimum
Loop, 0 to 1200 ohms	72% break maximum

Simplex Loop Current

10.36 If simplex power for the repeatered line is looped back at the remote terminal, loop current can be determined by measuring the dc voltage drop across the 10-ohm resistor between pins 26 and 28 of J1 (system 1), J3 (system 2), or J5 (spare). Multiplying the voltage by 100 gives the current in milliamperes; for example, 1.0 volt indicates 100 mA loop current.

Replacement of Air Filters

10.37 In the vented configuration of the 910A housing assembly, the four air filters should be replaced every six months; more frequently, if necessary. A high-temperature alarm at the central office may be an indication that filters are clogged. For replacement filters, order GTE Lenkurt stock no. 126-23846-04, quantity of four. Also, see paragraphs 8.25 through 8.27 for possible seasonal changes between vented and sealed configurations.

10.38 To change the intake filters at the botton of the housing (see figures 8-6 and 8-7):

(1) Remove battery compartment covers.

(2) Push filter down into lower channel until top edge of filter clears upper channel.

(3) Pull top edge of filter forward, lift filter out of lower channel, and remove.

(4) With air flow directional arrow pointing to the rear, insert bottom edge of new filter into lower channel and push down until top edge of filter clears upper channel.

(5) Push top edge of filter into upper channel.

(6) Adjust filter to a central position.

(7) Before replacing battery compartment covers, make sure lower screen and battery compartment are clean.

10.39 To change the exhaust filters at the top of the housing (see figure 8-6 and 8-7):

(1) For Model 2 housings, turn filter retainers 90 degrees and pull filters down, then remove. For Model 1 housings, pull filter down and remove. Filters fit tightly against foam sealing strips lining the opening and are secured at each end by spring clips.

(2) Make sure upper screen and adjacent area are clean. Screen may be removed for cleaning by unscrewing wingnuts (accessible through filter opening), lifting front edge of screen off two threaded studs, and pulling screen out rear of housing.

(3) Push new filter into opening with directional arrows pointing down. Exhaust filters are to prevent dust from entering when fan is off; therefore, arrows must point against flow of exhaust air.

Battery Inspection

10.40 Batteries in the 910A housing assemlby should be inspected at least annually and whenever the housing is opened for maintenance. A battery that is leaking electroylyte should be replaced. If there is corrosion at a battery terminal, proceed as follows:

(a) Remove in line fuses F1 and F2, as applicable (Model 2). Remove fuses F1 through F5, as applicable, to isolate the affected battery (Model 1).

(b) Disconnect and remove the battery from the housing. System will operate correctly from 117 Vac without batteries connected.

(c) On earlier model batteries, the terminals were protected by a nonremovable plastic cover. Using a pair of diagonal pliers, cut away this cover to expose at least 25-mm (1-inch) area around each terminal.

(d) Clean the battery terminals and the mating push-on connector with concentrated baking soda solution until all corrosion is removed.

(e) Reinstall the battery in the housing.

(f) Apply a coating of silicone rubber (such as General Electric type RTV-108) over each assembled battery terminal and push-on connector.

(g) Reinstall the fuses.

91270 Equipment Shelf

10.41 The 91271 Fuse and Alarm Unit and the 91272 Power Supply Unit plug into connectors on the 91270 shelf, but a screw at the rear of each unit must be removed before the unit can be unplugged. Also, three −48V leads are connected to terminal board TB1 at the rear of the 91271 unit.

Rear Access in the 910A Housing Assembly

10.42 Racks in the housing assembly can be pivoted about 160 degrees for access to wiring and components at the rear. Lift and secure the latch at the bottom of the rack on the inside edge and rotate the rack so the inside edge moves forward. Initially, a greater force is needed to unseat the foam sealing strip between the rack and its supporting frame.

Opening the 910A Housing Assembly

10.43 To open the housing assembly, remove the door padlock and lift the door up until it slides out of the mating grooves on the housing. For termporary storage, slide the door onto the boss at the end of the housing.

NOTE: As the door is removed, an alarm will be displayed on the auxiliary alarm panel at the central office.

Removal of Channel Units

10.44 When a CO channel unit is removed, the subscriber loop is opened and ringing to the subscriber is inhibited. However, removal of a 91263 unit during ringing will latch the 91262 unit at the subscriber end in the ringing mode. Removal of a remote channel unit closes the CO loop; if the channel is used for transmission of an auxiliary alarm indication, the alarm will be activated.

Emergency AC Power

10.45 The dc output voltage of the 55920 Battery Charger varies directly with ac input power frequency: 55 to 64 Hz at 117V (-01); 45 to 53 Hz at 220V (-02). Therefore, when emergency ac power for a 910A housing assembly is obtained from a portable power unit, the governor on the power unit should be adjusted while dc voltage is monitored at the −53V and GRD test points of either 55920 charger. Adjust for a meter reading of 53 volts. If the batteries in the 910A housing assembly have been heavily depleted, the 55920 chargers may operate initially in a current limiting mode and the dc voltage will not increase as the power frequency is increased. This effect, however, should last only a few minutes. When commerical ac power comes on, the external power unit will be disconnected automatically.

Troubleshooting

10.46 The primary method of troubleshooting the 910A equipment is by systematic replacement of plug-in units according to observed or measured symptoms. See figures 10-12 and 10-13. After a unit is replaced, test as necessary to verify normal operation. If a replacement unit does not clear the trouble, remove it and plug the original unit back into the shelf before continuing to the next unit.

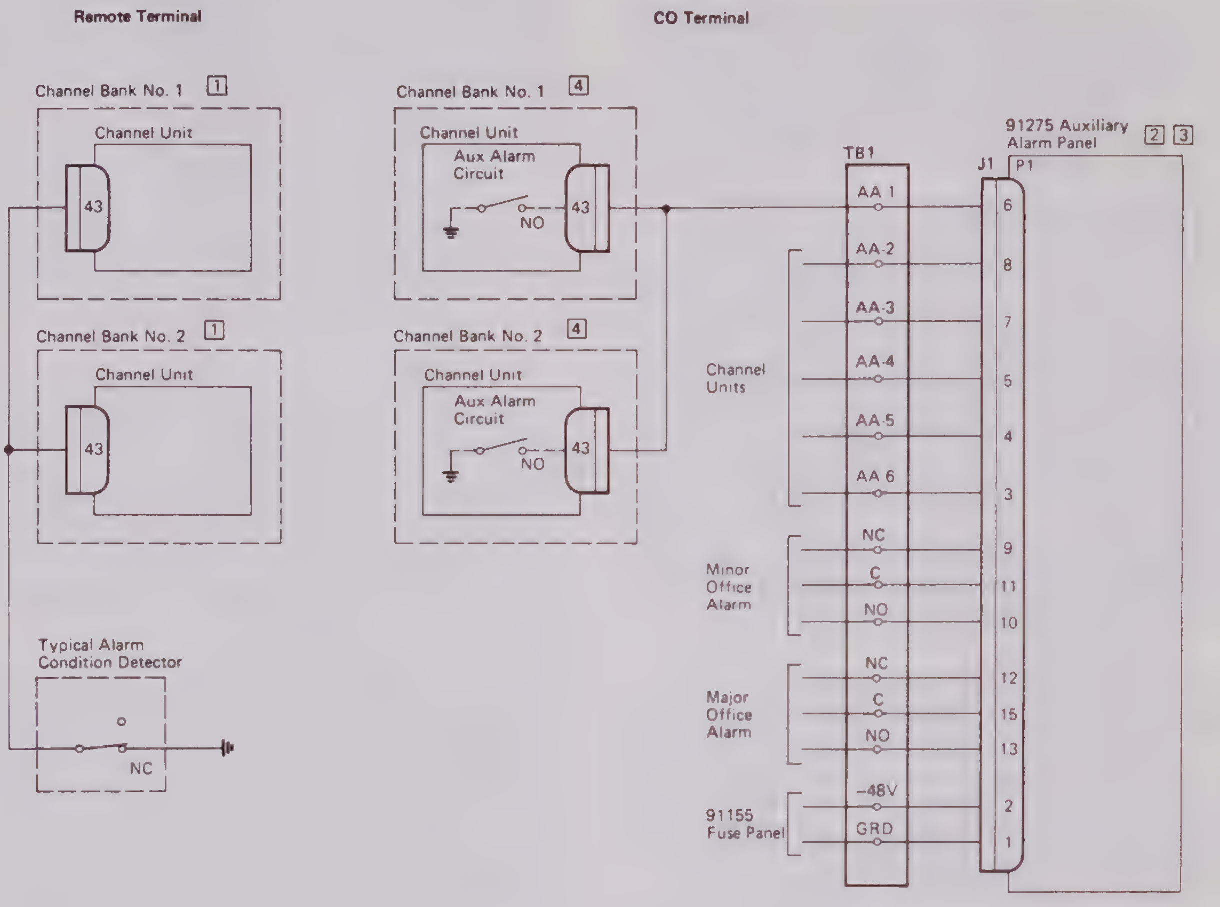
10.47 Trouble that is common to all channels of one system and does not produce a system alarm may be difficult to isolate to one end. A troubleshooting method that is useful on a 48-channel system, particularly if it is not in service, is to patch the channel bank of the good system to the span line of the failed system. Assuming trouble is on system 1, at the CO terminal patch the TRMT EQPT and RCV EQPT jacks on the 91112 repeater of system 2 to the TRMT SPAN and RCV SPAN jacks, respectively, on the 91112 repeater of system 1. If trouble clears, the problem is at the CO terminal. If the same trouble reappears, remove patch cords at the CO terminal and patch the system 2 channel bank to the system 1 span line at the remote terminal in the same manner.

CAUTION: If continuity checks of the channel bank shelf wiring are required, first unplug all channel units and common equipment units. There are two reasons for this precaution. One is the possibility of shorting adjacent pins on the shelf connectors and the other is the voltage on the multimeter leads. On the higher ohm ranges, this voltage exceeds the ratings of many integrated circuits.

10.48 Field repair of units is not recommended. Failures should be corrected by replacing the unit with a spare. Units should be tagged, with the defect or problem identified, and sent to GTE Lenkurt, San Carlos, Attention: Factory ▶Service Department. Normally, a unit will be repaired and returned within three weeks. If a spare is not available and ◀ down time is critical, this service can be accelerated or a temporary replacement can be furnished (GTE Lenkurt's CARE Program: Customer Accommodation Restoration Equipment). In any such emergency, contact a GTE Lenkurt Factory Service Representative: 415 595-3000.

10.49 For equipment out of warranty, there is only a repair charge. If a temporary CARE unit is required, there is an additional handling charge. Information on units being returned for repair may be furnished informally, either by mail or telephone, but should include a purchase order number as well as ship-to and bill-to addresses. Details on factory repair and CARE services can be obtained from any GTE Lenkurt Sales Representative. For further information, GTE companies should refer to GTE Practices Section 992-600-003, "Repair and Return, GTE Lenkurt Equipment". Other customers may obtain copies of the brochure "Factory Repair Service" (O-2631) from any GTE Lenkurt sales office.

Figure 10-3. Auxiliary Alarm Circuits, Wiring For an Office Installation


Remote Terminal
CO Terminal
Channel Bank No. 1 1
Channel Unit
43
Channel Bank No. 2 1
Channel Unit
43
Channel Bank No. 1 4
Channel Unit
Aux Alarm Circuit
NO
43
Channel Bank No. 2 4
Channel Unit
Aux Alarm Circuit
NO
43
Typical Alarm Condition Detector
NC
TB1
AA 1
AA-2
AA-3
AA-4
AA-5
AA 6
NC
C
NO
NC
C
NO
-48V
GRD
Channel Units
Minor Office Alarm
Major Office Alarm
91155 Fuse Panel
J1
P1
91275 Auxiliary Alarm Panel 2 3
6
8
7
5
4
3
9
11
10
12
15
13
2
1

Notes:

1 Unused Auxiliary Alarm Circuits. At the remote terminal, ground pin 43 on the shelf connector of each channel unit that is not used for transmission of auxiliary alarms.

2 91275 Auxiliary Alarm Panel. This diagram shows connections to Model 2 of the 91275 panel. The Model 1 panel has only one set of office alarm contacts, which are at J1-9 (NC), J1-12 (C), and J1-10 (NO).

3 Installer Wiring to 91275 Panel. Cable assembly 11 inches long, including TB1 and J1, is furnished with the 91275 panel. Mount TB1 on back of rack. Make external connections to wire-wrap terminals on TB1.

4 Channel Units at CO Terminal. The auxiliary alarm circuit that controls the AA lead is a solid-state switch.

Figure 10-4. Channel Units, Wiring For an Office Installation

Figure A. Office Channel Unit

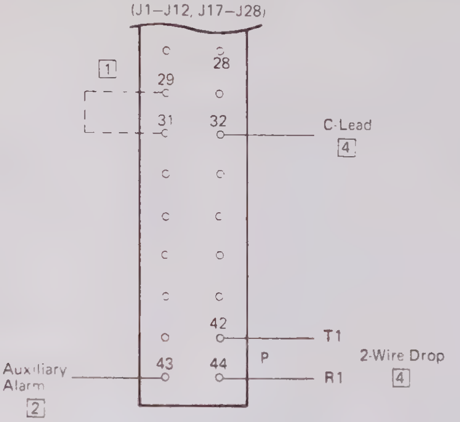

(J1–J12, J17–J28)
1
28
29
31
32
C-Lead
4
42
T1
43
44
P
2-Wire Drop
4
R1
Auxiliary Alarm
2

Figure B. Subscriber Channel Unit

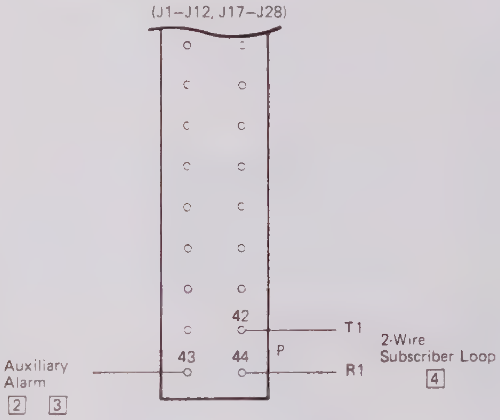
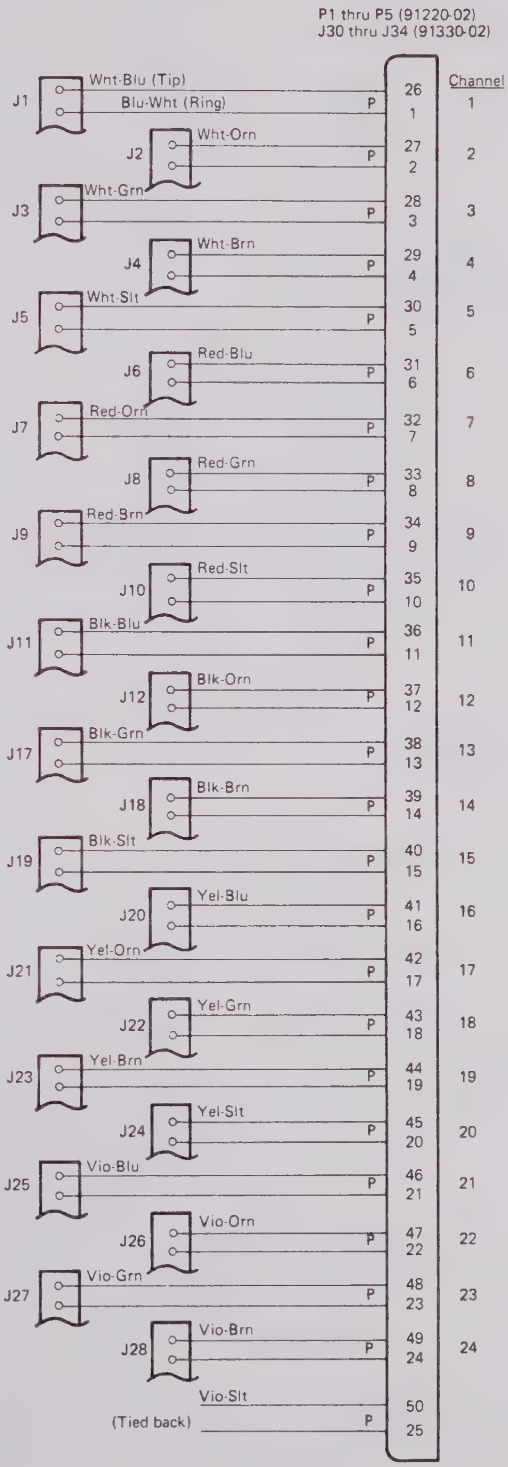

(J1–J12, J17–J28)
42
T1
43
44
P
2-Wire Subscriber Loop
4
R1
Auxiliary Alarm
2
3

Figure C. Wiring Diagram of Cable Pigtail On 91220-02 or 91330-02 Shelf [4]


P1 thru P5 (91220-02)
J30 thru J34 (91330-02)
Channel
J1 Wht-Blu (Tip) Blu-Wht (Ring) P 26 1 — 1
J2 Wht-Orn P 27 2 — 2
J3 Wht-Grn P 28 3 — 3
J4 Wht-Brn P 29 4 — 4
J5 Wht-Slt P 30 5 — 5
J6 Red-Blu P 31 6 — 6
J7 Red-Orn P 32 7 — 7
J8 Red-Grn P 33 8 — 8
J9 Red-Brn P 34 9 — 9
J10 Red-Slt P 35 10 — 10
J11 Blk-Blu P 36 11 — 11
J12 Blk-Orn P 37 12 — 12
J17 Blk-Grn P 38 13 — 13
J18 Blk-Brn P 39 14 — 14
J19 Blk-Slt P 40 15 — 15
J20 Yel-Blu P 41 16 — 16
J21 Yel-Orn P 42 17 — 17
J22 Yel-Grn P 43 18 — 18
J23 Yel-Brn P 44 19 — 19
J24 Yel-Slt P 45 20 — 20
J25 Vio-Blu P 46 21 — 21
J26 Vio-Orn P 47 22 — 22
J27 Vio-Grn P 48 23 — 23
J28 Vio-Brn P 49 24 — 24
Vio-Slt (Tied back) P 50 25

Notes:

[1] C-Lead. Contacts 31 and 32 on the shelf connector close when the office channel unit is unplugged. If the C-lead busy feature is wired to the channel bank, strap connector pin 31 to 29 (31 to 28 on the 91220 Terminal Equipment Shelf, models 1 and 2 and model 3 Issue 1).

[2] Auxiliary Alarm Circuits. For wiring of auxiliary alarm circuits, see figure 10-1.

[3] Unused Auxiliary Alarm Circuits. At the remote terminal, ground pin 43 on the shelf connector of each subscriber channel unit not used for transmission of auxiliary alarms.

[4] Terminal Equipment Shelf. When the channel bank uses the 91220-02 shelf, certain installer connections are made via 25-pair cable pigtails terminated in 50-pin male connectors. Figure C is a wiring diagram of the cable pigtail. Color code shown is for the tip lead of the pair; the first color is a wide stripe and the second color is a narrow stripe. Colors are reversed on the ring lead. Pair assignments are listed below.

The 91330-02 shelf also includes the wiring shown in Figure C but as individual pairs not in a cable pigtail. The 50-pin connectors are female and affixed to the shelf.

Pigtail Color Code	50-Pin Connector		Pins on J1-J12 and J17-J28 (Tip/Ring of Pair)	Assignment in 910A System
	91220-02	91330-02		
Green	P3	J31	34/32	C-lead (pin 32 of office channel unit)
Slate	P5	J32	35/36	Not used
Blue	P1	J30	38/40	Not used
Brown	P4	J34	39/41	Not used
Orange	P2	J33	42/44	T1/R1 of 2 wire subscriber loop or drop

Figure 10-5. 91270-01 and -02 Equiment Shelves, Wiring For an Office Installation (Sheet 1 of 3)

Figure A. Input Power

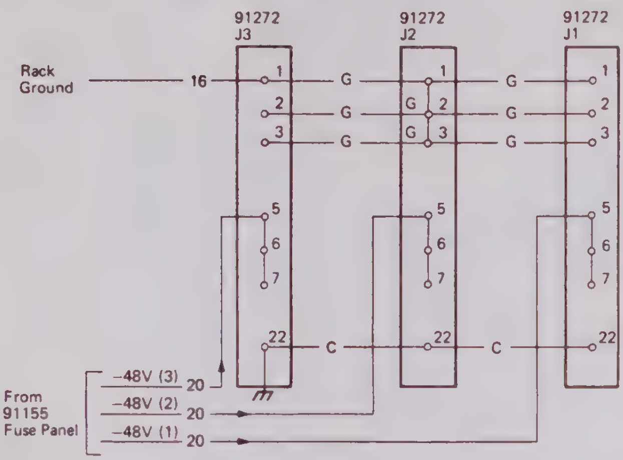

91272 J3
91272 J2
91272 J1
Rack Ground
16
1
2
3
5
6
7
22
G
C
−48V (3)
−48V (2)
−48V (1)
20
From 91155 Fuse Panel

Figure B. Coin Control and Ringing Voltages 8

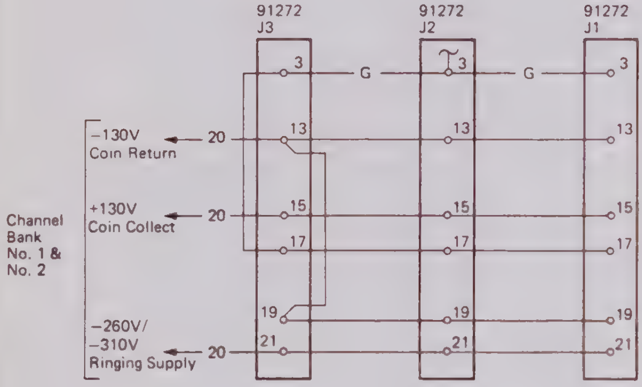

91272 J3
91272 J2
91272 J1
3
13
15
17
19
21
G
−130V Coin Return
+130V Coin Collect
−260V/ −310V Ringing Supply
20
Channel Bank No. 1 & No. 2

Figure C. Span Power at +130V and −130V

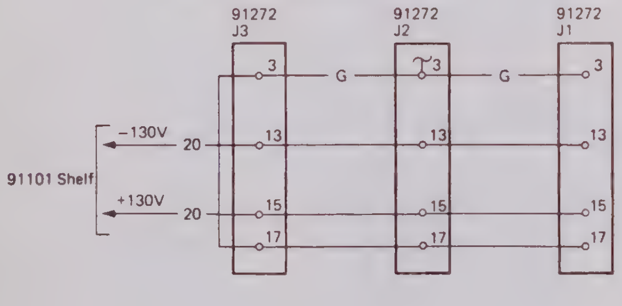

91272 J3
91272 J2
91272 J1
3
13
15
17
G
−130V
+130V
20
91101 Shelf

Figure D. Span Power at −130V

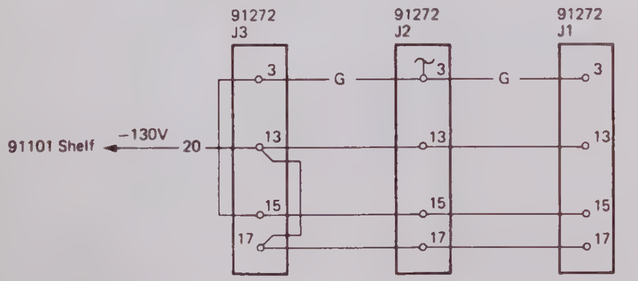

91272 J3
91272 J2
91272 J1
3
13
15
17
G
91101 Shelf
−130V
20

Figure E. Span Power at +130V 8

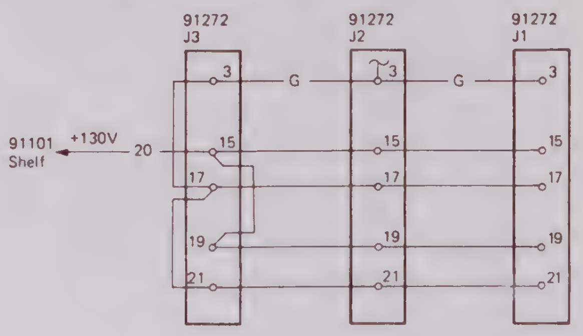

91272 J3
91272 J2
91272 J1
3
15
17
19
21
G
91101 Shelf
+130V
20

Figure F. Auxiliary Alarm Control at Remote Terminal 6

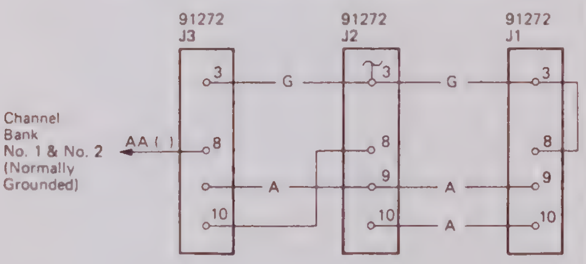

91272 J3
91272 J2
91272 J1
3
8
9
10
G
A
AA ( )
Channel Bank No. 1 & No. 2 (Normally Grounded)

Figure G. Local Alarm Control

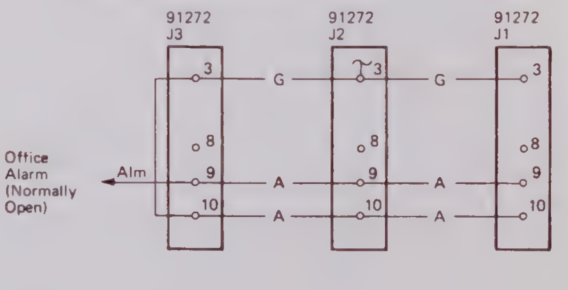
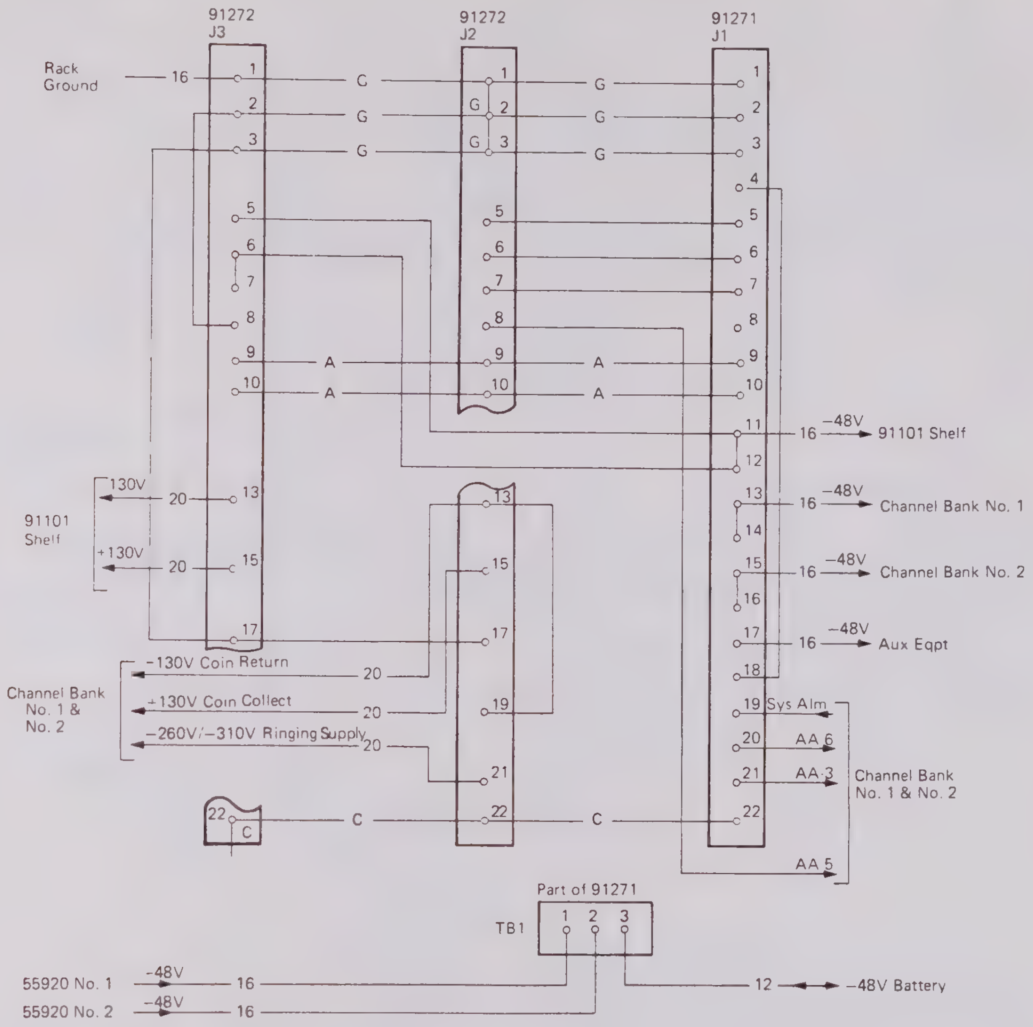

91272 J3
91272 J2
91272 J1
3
8
9
10
G
A
Alm
Office Alarm (Normally Open)

Figure 10-5. 91270-01 and -02 Equiment Shelves, Wiring For an Office Installation (Sheet 2 of 3)

Figure H. 91270-01 Equipment Shelf With 91271 Fuse and Alarm Unit [5] [7] [8]


91272
J3
91272
J2
91271
J1
Rack Ground
16
G
G
G
G
G
G
A
A
A
A
−48V
16
91101 Shelf
−48V
16
Channel Bank No. 1
−48V
16
Channel Bank No. 2
−48V
16
Aux Eqpt
Sys Alm
AA 6
AA 3
AA 5
Channel Bank No. 1 & No. 2
91101 Shelf
−130V
20
+130V
20
Channel Bank No. 1 & No. 2
−130V Coin Return
20
+130V Coin Collect
20
−260V/−310V Ringing Supply
20
C
C
C
Part of 91271
TB1
1 2 3
55920 No. 1
−48V
16
55920 No. 2
−48V
16
12
−48V Battery

Notes

1. Installer Wiring. For an office installation of a 91270 shelf, install intra-shelf and external wiring in accordance with the applicable figures listed in the table below.

Output Power	Figures		Maximum Load
	Remote Terminal	CO Terminal	
Coin control and ringing	A,B,F		48 channels per 91272 unit
Span power at +130V and −130V	A,C,F	A,C,G	330 mA (at 260V) per 91272 unit
Span power at −130V	A,D,F	A,D,G	660 mA per 91272 unit
Span power at +130V	A,E,F	A,E,G	600 mA per 91272 unit
Coin control and ringing; span power at +130V and −130V	H		48 channels; 330 mA span power (at 260V)

2 Wire Size. Typically −20− denotes 20 AWG (0.80 mm). If size is unspecified, installer wiring is 22 AWG (0.63 mm).

3. Factory Wiring. Factory wiring is denoted by A (alarm), C (chassis ground), and G (power ground).

4. Shelf Connectors. Shelf connectors (and mounting positions) are designated J1, J2, and J3 from left to right as viewed from the front.

[5] Equipment Options. For figures Hand J application, use 91271 unit in position J1 and 91272 units in positions J2 and J3. For other applications, use one, two, or three 91272 units, as required.

[6] Auxiliary Alarm (Figure F). Remove factory installed jumper between J2-10 and J3-10. Strap pin 8 to pin 10 on the shelf connector of unequipped mounting positions.

[7] Auxiliary Alarm (Figures H and J). Strap J3-8 to J3-10 if the 91272 unit is not equipped at position J3.

[8] 130V/180V Output of 91272 Unit. See figure 3-3 for strapping.

]

▶ Figure 10-5. 91270-01 and -02 Equiment Shelves, Wiring For an Office Installation (Sheet 3 of 3)

Figure J. 91270-02 Equipment Shelf With 91271 Fuse and Alarm Unit 5 7 8

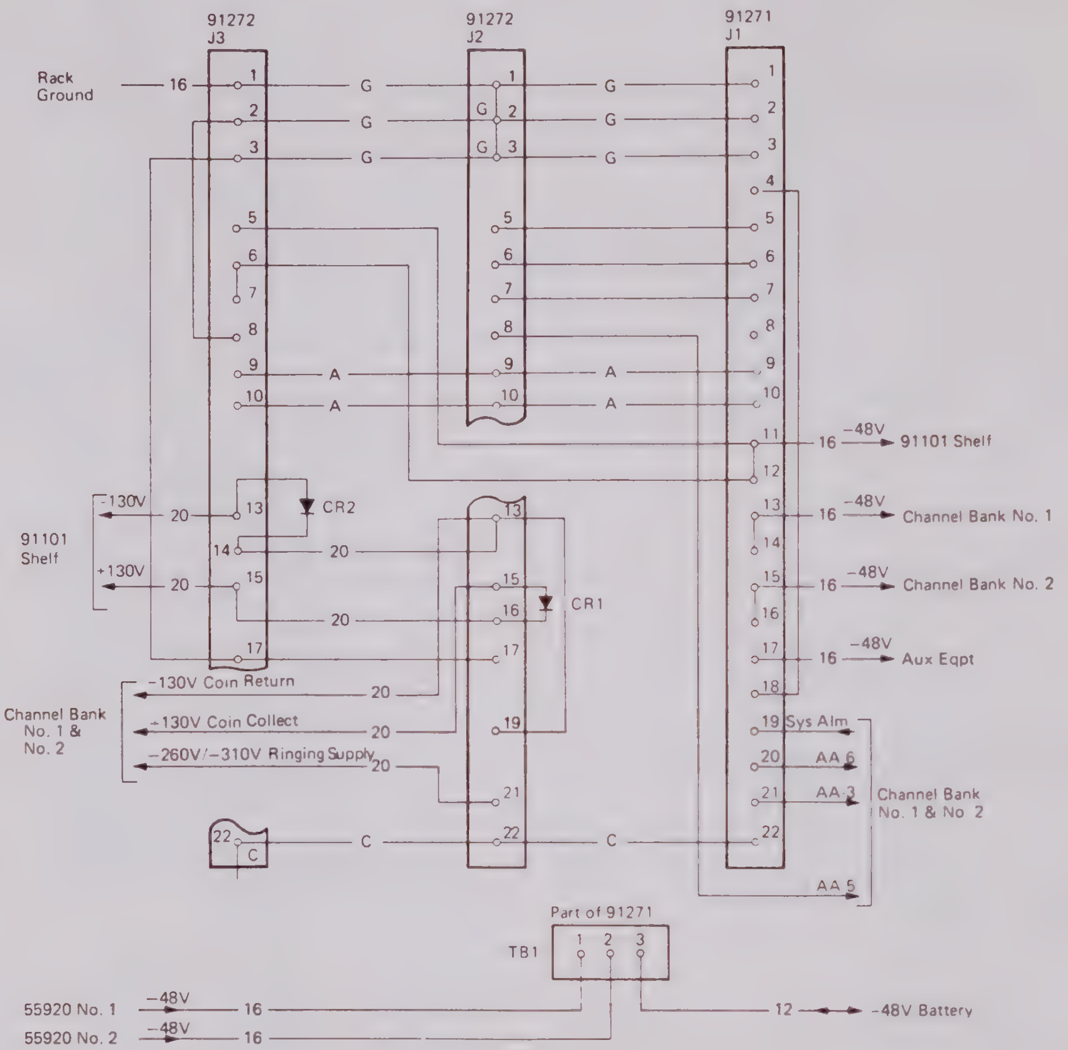

91272
J3
91272
J2
91271
J1
Rack Ground
16
G
A
C
CR2
CR1
91101 Shelf
-130V
+130V
20
-130V Coin Return
+130V Coin Collect
-260V/-310V Ringing Supply
Channel Bank No. 1 & No. 2
-48V
91101 Shelf
Channel Bank No. 1
Channel Bank No. 2
Aux Eqpt
Sys Alm
AA 6
AA 3
AA 5
Channel Bank No. 1 & No 2
Part of 91271
TB1
1 2 3
55920 No. 1
55920 No. 2
12
-48V Battery

Figure 10-6. Typical Remote Terminal Office Installation, Circuit Diagram (Sheet 1 of 2)

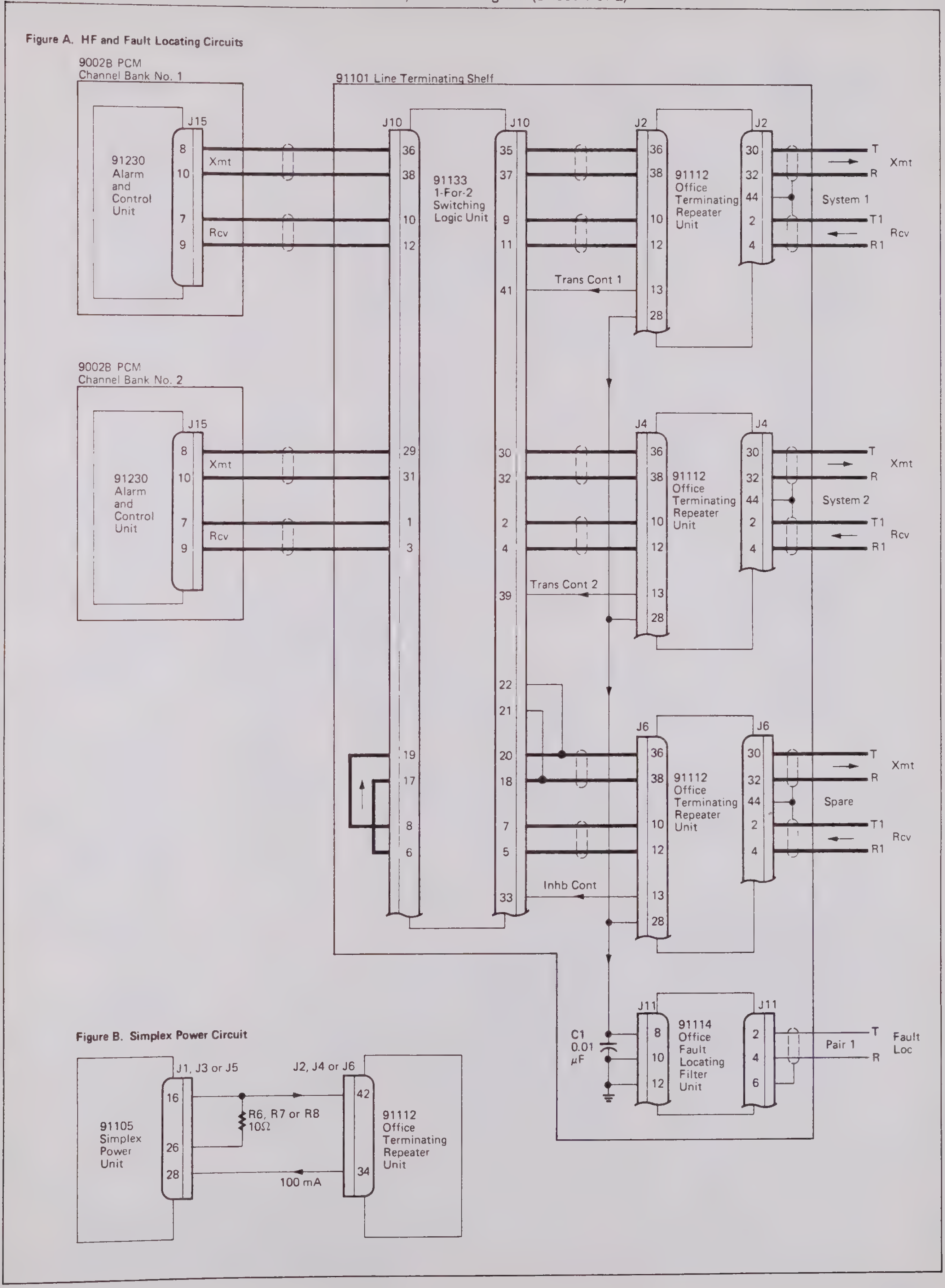


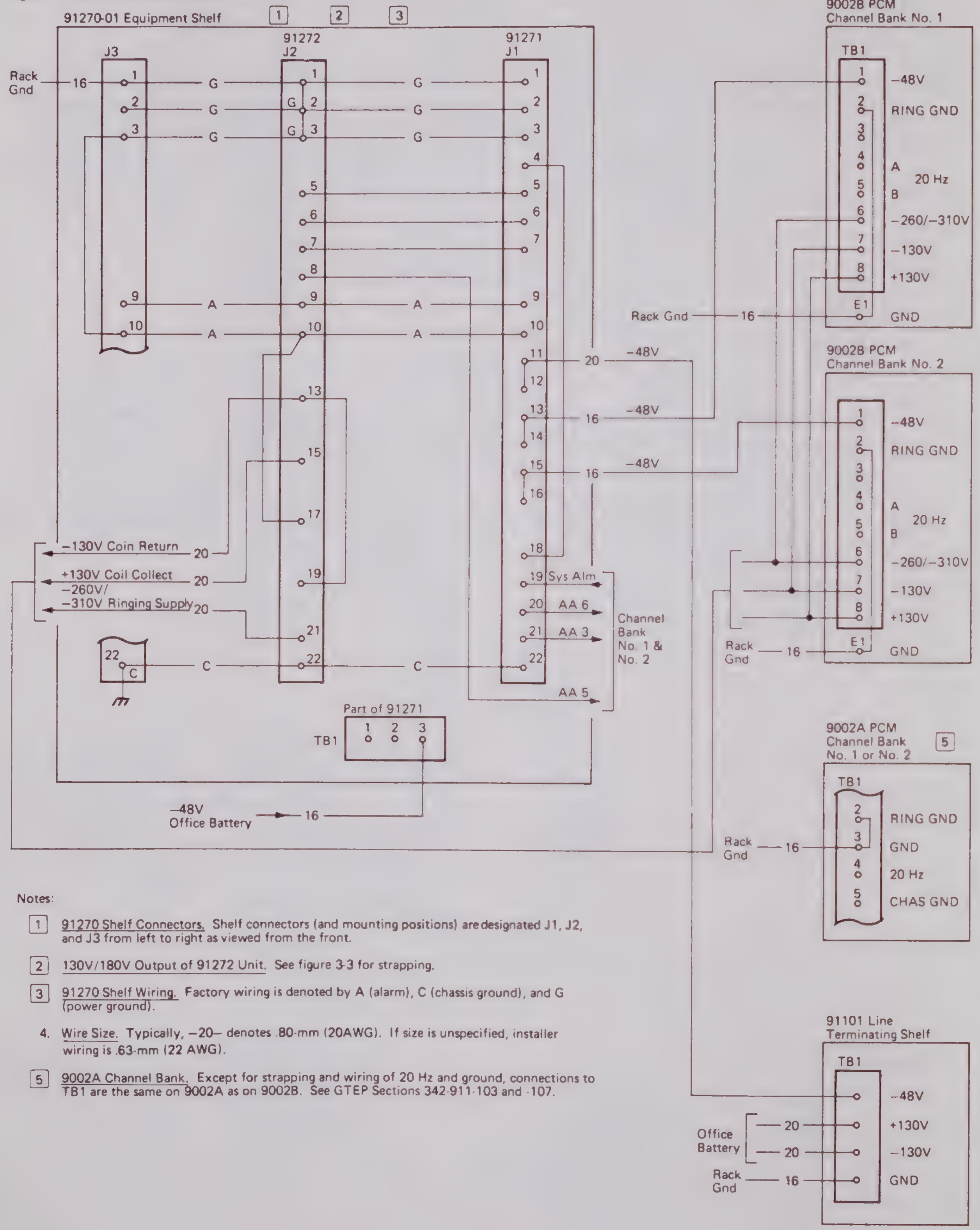
Figure A. HF and Fault Locating Circuits

Figure B. Simplex Power Circuit

9002B PCM Channel Bank No. 1
91230 Alarm and Control Unit
J15
8
10
7
9
Xmt
Rcv
91101 Line Terminating Shelf
J10
36
38
10
12
91133 1-For-2 Switching Logic Unit
J10
35
37
9
11
41
Trans Cont 1
J2
36
38
10
12
13
28
91112 Office Terminating Repeater Unit
J2
30
32
44
2
4
T
R
T1
R1
Xmt
Rcv
System 1
9002B PCM Channel Bank No. 2
91230 Alarm and Control Unit
J15
8
10
7
9
Xmt
Rcv
29
31
1
3
30
32
2
4
39
Trans Cont 2
J4
36
38
10
12
13
28
91112 Office Terminating Repeater Unit
J4
30
32
44
2
4
T
R
T1
R1
Xmt
Rcv
System 2
22
21
19
17
8
6
20
18
7
5
33
Inhb Cont
J6
36
38
10
12
13
28
91112 Office Terminating Repeater Unit
J6
30
32
44
2
4
T
R
T1
R1
Xmt
Rcv
Spare
C1 0.01 μF
J11
8
10
12
91114 Office Fault Locating Filter Unit
J11
2
4
6
Pair 1
T
R
Fault Loc
91105 Simplex Power Unit
J1, J3 or J5
16
26
28
R6, R7 or R8 10Ω
100 mA
J2, J4 or J6
42
34
91112 Office Terminating Repeater Unit

Figure 10-6. Typical Remote Terminal Office Installation, Circuit Diagram (Sheet 2 of 2)

Figure C. Power Distribution Circuits


91270-01 Equipment Shelf
1
2
3
J3
91272
J2
91271
J1
Rack Gnd
16
G
A
C
22
−130V Coin Return
+130V Coil Collect
−260V/
−310V Ringing Supply
20
Sys Alm
AA 6
AA 3
AA 5
Channel Bank No. 1 & No. 2
−48V
Part of 91271
TB1
−48V Office Battery
9002B PCM Channel Bank No. 1
9002B PCM Channel Bank No. 2
RING GND
20 Hz
−260/−310V
−130V
+130V
GND
E1
9002A PCM Channel Bank No. 1 or No. 2
5
CHAS GND
91101 Line Terminating Shelf
Office Battery

Notes:

1 91270 Shelf Connectors. Shelf connectors (and mounting positions) are designated J1, J2, and J3 from left to right as viewed from the front.

2 130V/180V Output of 91272 Unit. See figure 3-3 for strapping.

3 91270 Shelf Wiring. Factory wiring is denoted by A (alarm), C (chassis ground), and G (power ground).

4. Wire Size. Typically, −20– denotes .80-mm (20AWG). If size is unspecified, installer wiring is .63-mm (22 AWG).

5 9002A Channel Bank. Except for strapping and wiring of 20 Hz and ground, connections to TB1 are the same on 9002A as on 9002B. See GTEP Sections 342-911-103 and -107.

Figure 10-7. 910A Housing Assembly, Circuit Diagram (Sheet 1 of 8)

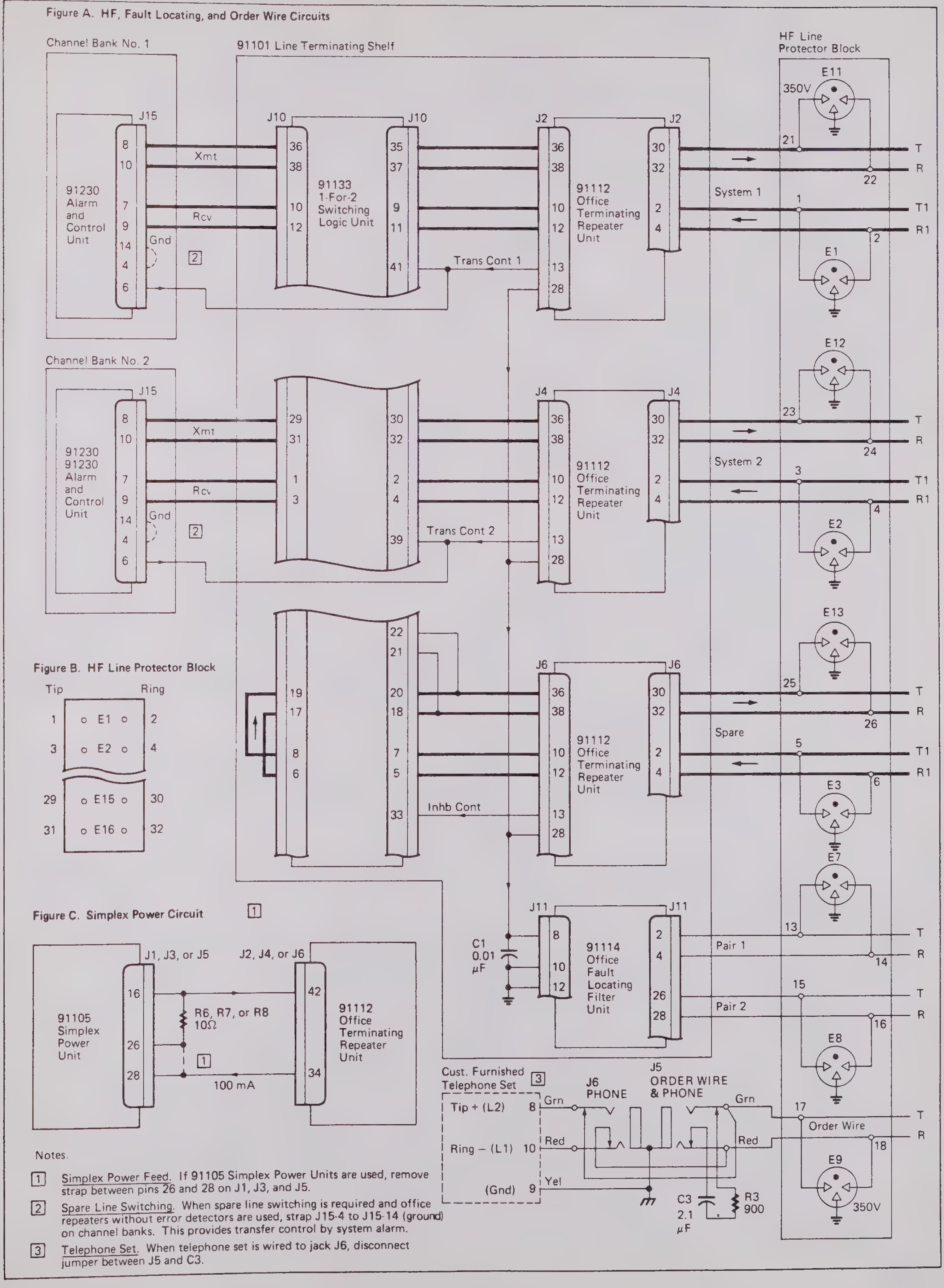


Figure A. HF, Fault Locating, and Order Wire Circuits
Channel Bank No. 1
91101 Line Terminating Shelf
HF Line Protector Block
E11
350V
J15
J10
J10
J2
J2
91230 Alarm and Control Unit
Xmt
Rcv
Gnd
2
91133 1-For-2 Switching Logic Unit
Trans Cont 1
91112 Office Terminating Repeater Unit
System 1
T
R
T1
R1
21
22
1
2
E1
E12
Channel Bank No. 2
J4
J4
91230 91230 Alarm and Control Unit
Trans Cont 2
System 2
23
24
3
4
E2
E13
J6
J6
Spare
25
26
5
6
E3
E7
Inhb Cont
Figure B. HF Line Protector Block
Tip
Ring
E1
E2
E15
E16
J11
J11
C1 0.01 µF
91114 Office Fault Locating Filter Unit
Pair 1
Pair 2
13
14
15
16
E8
Figure C. Simplex Power Circuit
1
91105 Simplex Power Unit
J1, J3, or J5
J2, J4, or J6
R6, R7, or R8 10Ω
100 mA
91112 Office Terminating Repeater Unit
Cust. Furnished Telephone Set
3
Tip + (L2)
Ring – (L1)
(Gnd)
Grn
Red
Yel
J6 PHONE
J5 ORDER WIRE & PHONE
C3 2.1 µF
R3 900
Order Wire
17
18
E9
350V

Notes.

1 Simplex Power Feed. If 91105 Simplex Power Units are used, remove strap between pins 26 and 28 on J1, J3, and J5.

2 Spare Line Switching. When spare line switching is required and office repeaters without error detectors are used, strap J15-4 to J15-14 (ground) on channel banks. This provides transfer control by system alarm.

3 Telephone Set. When telephone set is wired to jack J6, disconnect jumper between J5 and C3.

Figure 10-7. 910A Housing Assembly, Circuit Diagram (Sheet 2 of 8)

Figure D. Subscriber Loop Circuits 7

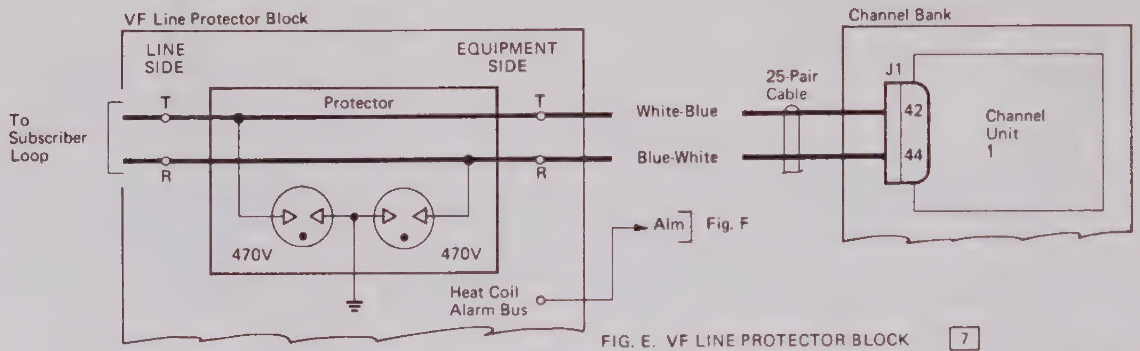
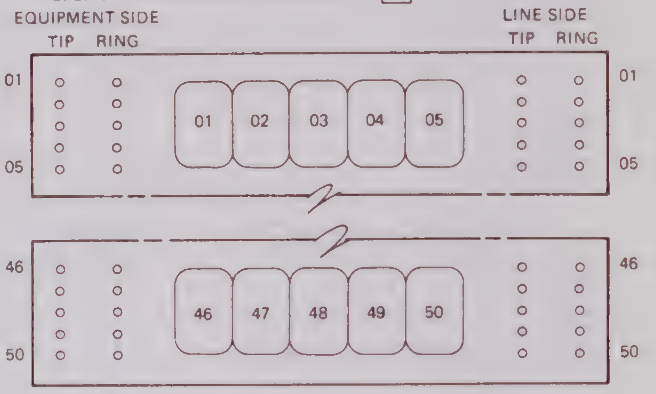

VF Line Protector Block
LINE SIDE
EQUIPMENT SIDE
To Subscriber Loop
T
R
Protector
T
R
470V
470V
Heat Coil Alarm Bus
White-Blue
Blue-White
25-Pair Cable
Alm
Fig. F
Channel Bank
J1
42
44
Channel Unit 1

FIG. E. VF LINE PROTECTOR BLOCK 7


EQUIPMENT SIDE
TIP
RING
LINE SIDE
TIP
RING
01
05
01
02
03
04
05
01
05
46
50
46
47
48
49
50
46
50

Notes:

4 Unused Auxiliary Alarm Circuits. On channel bank no. 1 and no. 2, pin 43 is grounded on J7 through J12 and J17 through J28.

5 91270 Shelf Alarm Circuits. On the 91270 Equipment Shelf, wiring at J1-9, J1-10, J2-9, and J3-9 is not used.

6 Span Power Supply. When a 91272 Power Supply Unit is installed at J3 to furnish span power, cut the strap between pins 3 and 10 on J2.

7 VF Line Protector Block. A 25-pair cable is run from the vf line protector block to each channel bank. Pair assignments are listed below.

Chan	Protector		Cable Color Code	Chan Bank
	Sys 1	Sys 2		
1	01	26	White-Blue	J1
2	02	27	White-Orange	J2
3	03	28	White-Green	J3
4	04	29	White-Brown	J4
5	05	30	White-Slate	J5
6	06	31	Red-Blue	J6
7	07	32	Red-Orange	J7
8	08	33	Red-Green	J8
9	09	34	Red-Brown	J9
10	10	35	Red-Slate	J10
11	11	36	Black-Blue	J11
12	12	37	Black-Orange	J12
13	13	38	Black-Green	J17
14	14	39	Black-Brown	J18
15	15	40	Black-Slate	J19
16	16	41	Yellow-Blue	J20
17	17	42	Yellow-Orange	J21
18	18	43	Yellow-Green	J22
19	19	44	Yellow-Brown	J23
20	20	45	Yellow-Slate	J24
21	21	46	Violet-Blue	J25
22	22	47	Violet-Orange	J26
23	23	48	Violet-Green	J27
24	24	49	Violet-Brown	J28
	25	50	Violet-Slate	

Color code listed is for tip lead of pair; first color is wide stripe and second color is narrow stripe. Colors are reversed on ring lead.

Violet-Slate pairs are tied back at channel bank.

8 Effective with 55910-M2, Issue 4, K1 pins are identified as follows:

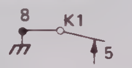


FIG. F. AUXILIARY ALARM CIRCUITS 4 5 6

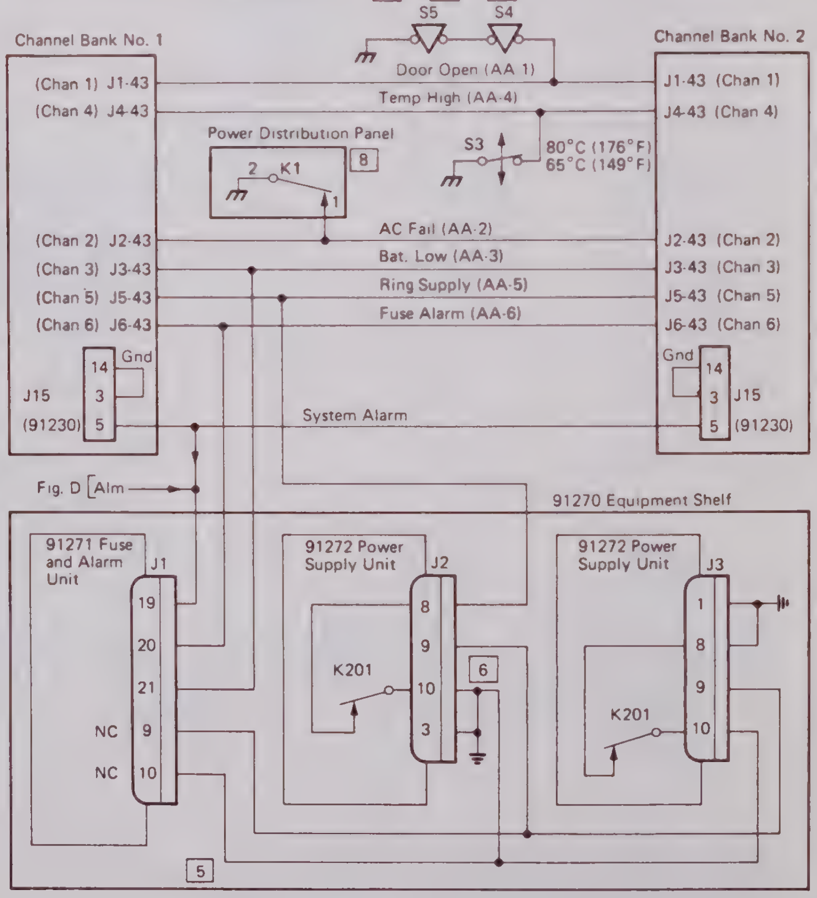
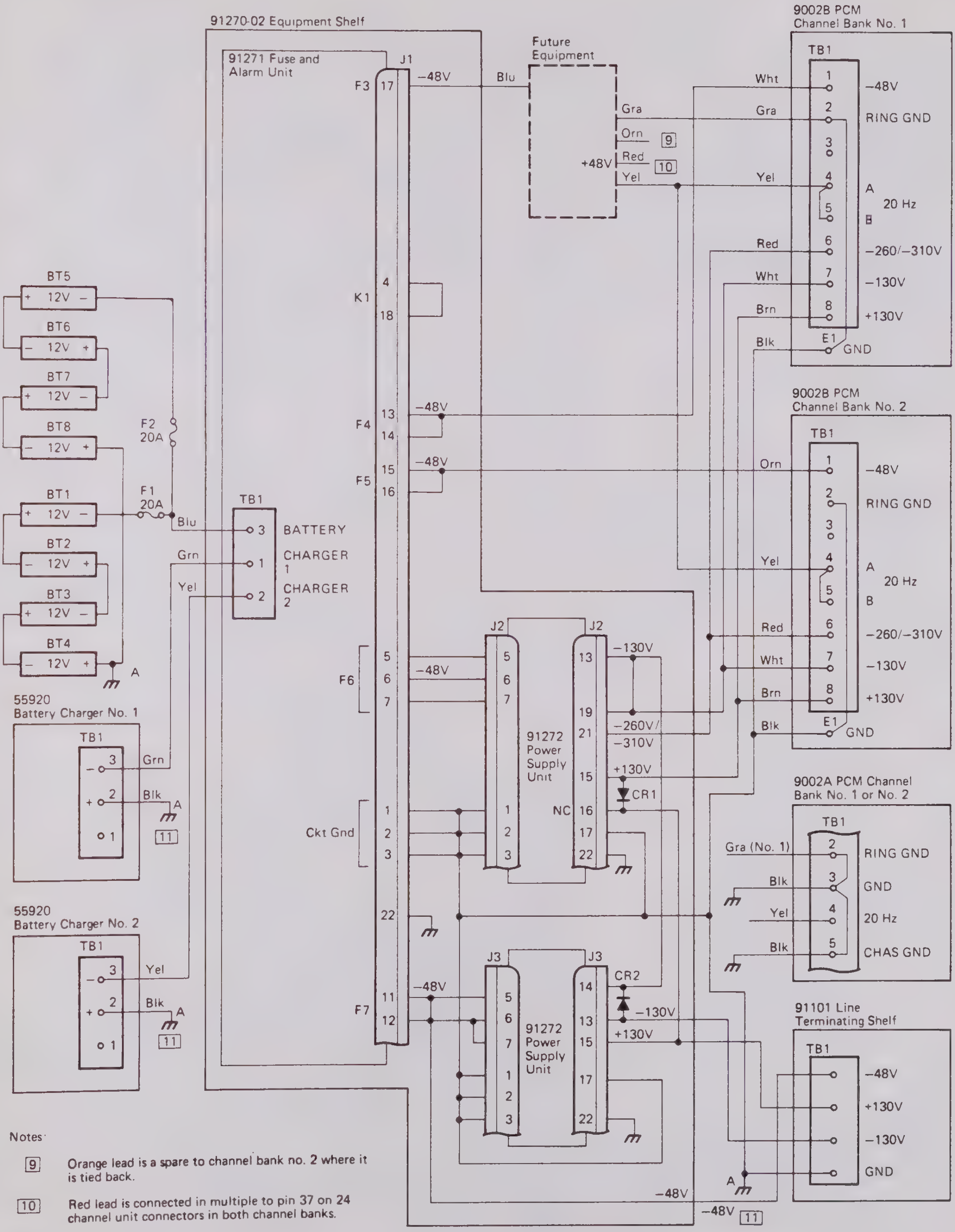

S5
S4
Channel Bank No. 1
Channel Bank No. 2
Door Open (AA-1)
(Chan 1) J1-43
J1-43 (Chan 1)
Temp High (AA-4)
(Chan 4) J4-43
J4-43 (Chan 4)
Power Distribution Panel
8
2
K1
1
S3
80°C (176°F)
65°C (149°F)
AC Fail (AA-2)
(Chan 2) J2-43
J2-43 (Chan 2)
Bat. Low (AA-3)
(Chan 3) J3-43
J3-43 (Chan 3)
Ring Supply (AA-5)
(Chan 5) J5-43
J5-43 (Chan 5)
Fuse Alarm (AA-6)
(Chan 6) J6-43
J6-43 (Chan 6)
Gnd
14
3
5
J15
(91230)
Gnd
14
3
5
J15
(91230)
System Alarm
Fig. D
Alm
91270 Equipment Shelf
91271 Fuse and Alarm Unit
J1
19
20
21
NC 9
NC 10
91272 Power Supply Unit
J2
8
9
10
3
K201
6
91272 Power Supply Unit
J3
1
8
9
10
K201
5

Figure 10-7. 910A Housing Assembly, Circuit Diagram (Sheet 3 of 8)

Figure G. DC Power Distribution (Model 2 Housing)


91270-02 Equipment Shelf
91271 Fuse and Alarm Unit
J1
F3
17
−48V
Blu
Future Equipment
Gra
Orn
9
Red
10
+48V
Yel
9002B PCM Channel Bank No. 1
TB1
Wht
Gra
Yel
Red
Wht
Brn
Blk
1
2
3
4
5
6
7
8
E1
−48V
RING GND
A
20 Hz
B
−260/−310V
−130V
+130V
GND
BT5
12V
BT6
BT7
BT8
K1
4
18
F2
20A
F4
13
14
−48V
9002B PCM Channel Bank No. 2
F5
15
16
Orn
BT1
BT2
BT3
BT4
F1
20A
Blu
Grn
Yel
TB1
3
1
2
BATTERY
CHARGER 1
CHARGER 2
A
55920 Battery Charger No. 1
TB1
Grn
Blk
11
F6
5
6
7
J2
J2
13
−130V
19
21
−260V/−310V
15
+130V
CR1
NC
16
17
22
91272 Power Supply Unit
Ckt Gnd
1
2
3
9002A PCM Channel Bank No. 1 or No. 2
Gra (No. 1)
Blk
Yel
Blk
RING GND
GND
20 Hz
CHAS GND
55920 Battery Charger No. 2
22
J3
J3
F7
11
12
−48V
14
CR2
−130V
+130V
91272 Power Supply Unit
91101 Line Terminating Shelf
TB1
−48V
+130V
−130V
GND
−48V
−48V
11

Notes·

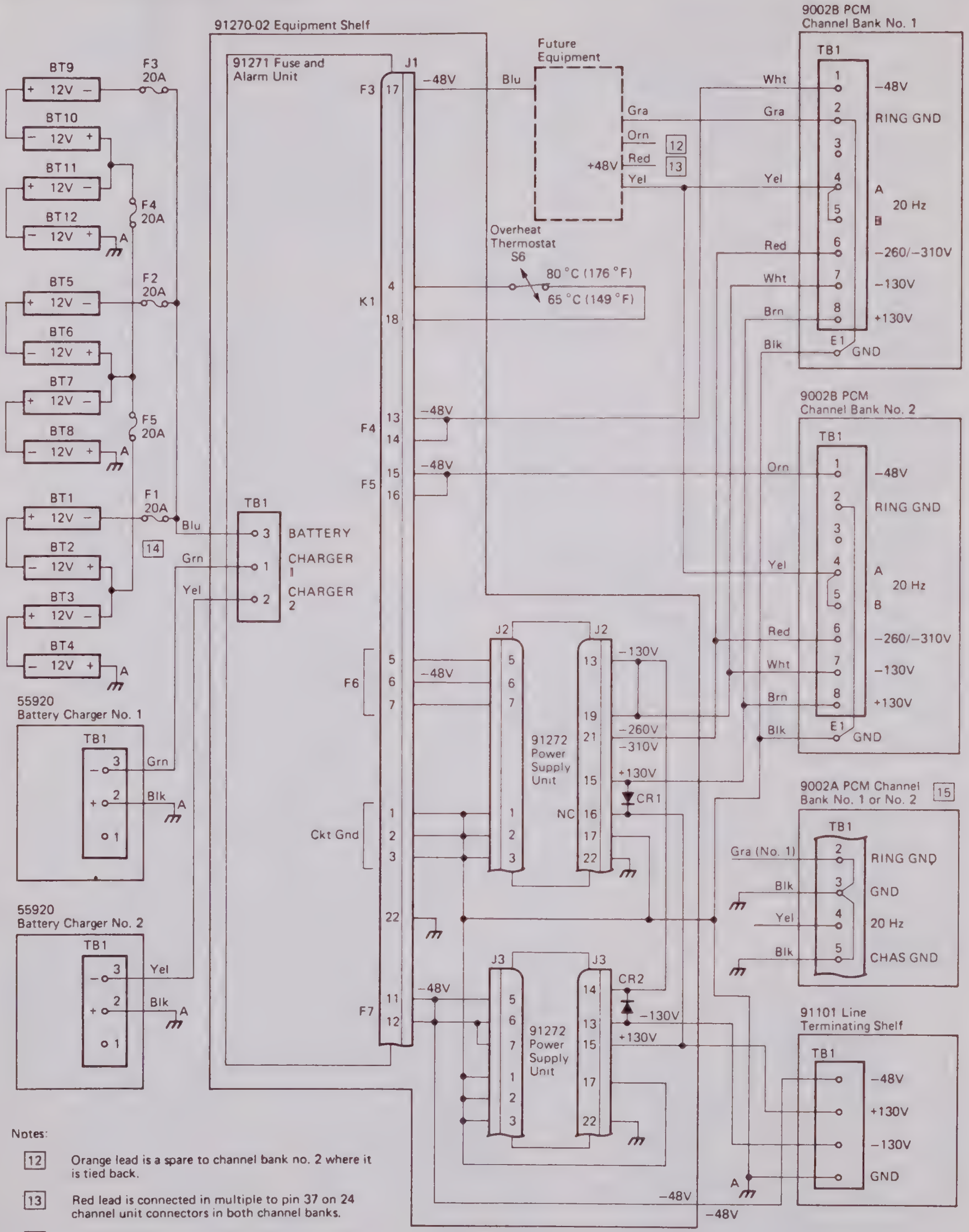
9 Orange lead is a spare to channel bank no. 2 where it is tied back.

10 Red lead is connected in multiple to pin 37 on 24 channel unit connectors in both channel banks.

11 A is rack ground at batteries.

Figure 10-7. 910A Housing Assembly, Circuit Diagram (Sheet 4 of 8)

Figure H. Dc Power Distribution (Model 1 Housing)


91270-02 Equipment Shelf
91271 Fuse and Alarm Unit
J1
BT9 + 12V −
BT10 − 12V +
BT11 + 12V −
BT12 − 12V +
F3 20A
F4 20A
A
BT5 + 12V −
BT6 − 12V +
BT7 + 12V −
BT8 − 12V +
F2 20A
F5 20A
BT1 + 12V −
BT2 − 12V +
BT3 + 12V −
BT4 − 12V +
F1 20A
14
Blu
Grn
Yel
TB1
3 BATTERY
1 CHARGER 1
2 CHARGER 2
55920 Battery Charger No. 1
TB1
3 − Grn
2 + Blk
1
55920 Battery Charger No. 2
TB1
3 − Yel
2 + Blk
1
F3 17 −48V
K1 4 18
F4 13 14 −48V
F5 15 16 −48V
F6 5 6 7 −48V
Ckt Gnd 1 2 3
22
F7 11 12 −48V
Blu
Future Equipment
Gra
Orn 12
+48V Red 13
Yel
Overheat Thermostat S6
80 °C (176 °F)
65 °C (149 °F)
J2
5 6 7 1 2 3
91272 Power Supply Unit
J2
13 19 21 15 NC 16 17 22
−130V
−260V
−310V
+130V
CR1
J3
5 6 7 1 2 3
91272 Power Supply Unit
J3
14 13 15 17 22
CR2
−130V
+130V
−48V
−48V
A
9002B PCM Channel Bank No. 1
TB1
Wht 1 −48V
Gra 2 RING GND
3
Yel 4 A
5 B 20 Hz
Red 6 −260/−310V
Wht 7 −130V
Brn 8 +130V
Blk E1 GND
9002B PCM Channel Bank No. 2
TB1
Orn 1 −48V
2 RING GND
3
Yel 4 A
5 B 20 Hz
Red 6 −260/−310V
Wht 7 −130V
Brn 8 +130V
Blk E1 GND
9002A PCM Channel Bank No. 1 or No. 2 15
TB1
Gra (No. 1) 2 RING GND
Blk 3 GND
Yel 4 20 Hz
Blk 5 CHAS GND
91101 Line Terminating Shelf
TB1
−48V
+130V
−130V
GND

Notes:

12 Orange lead is a spare to channel bank no. 2 where it is tied back.

13 Red lead is connected in multiple to pin 37 on 24 channel unit connectors in both channel banks.

14 F1 thru F5 are on a fuse block between rack 1 and rack 2. F1 is at the bottom. Ground point "A" is just above F5.

15 Except for strapping and ground wiring, connections to TB1 are the same on 9002A as on 9002B.

Figure 10-7. 910A Housing Assembly, Circuit Diagram (Sheet 5 of 8)

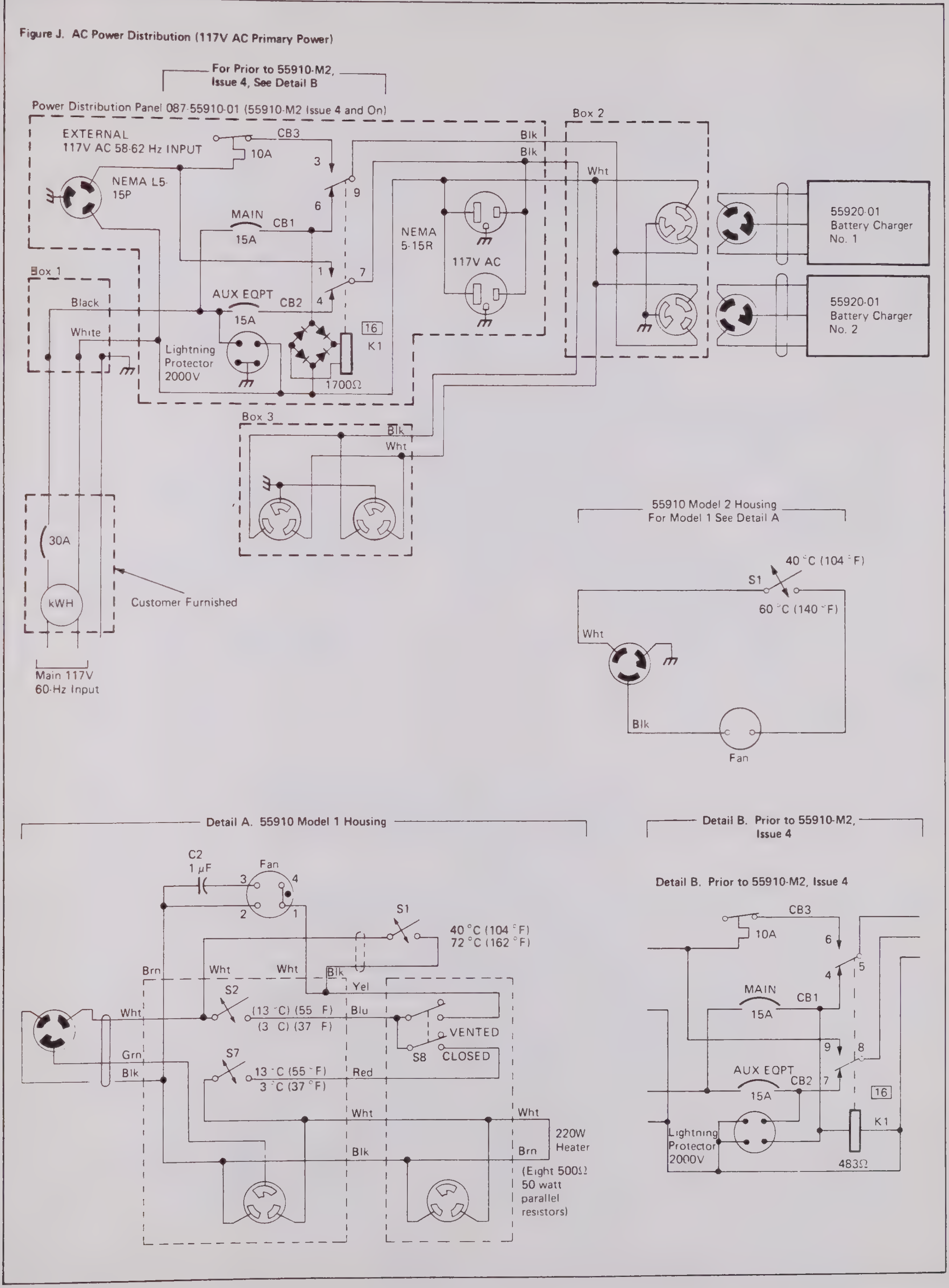


Figure J. AC Power Distribution (117V AC Primary Power)

55910 Model 2 Housing For Model 1 See Detail A

Detail A. 55910 Model 1 Housing

Detail B. Prior to 55910-M2, Issue 4

For Prior to 55910-M2, Issue 4, See Detail B
Power Distribution Panel 087-55910-01 (55910-M2 Issue 4 and On)
EXTERNAL
117V AC 58-62 Hz INPUT
CB3
10A
NEMA L5-15P
3
9
6
MAIN
CB1
15A
1
7
AUX EQPT
CB2
4
15A
16
K1
Lightning Protector 2000V
1700Ω
NEMA 5-15R
117V AC
Blk
Blk
Wht
Box 1
Black
White
Box 2
Box 3
Blk
Wht
55920-01 Battery Charger No. 1
55920-01 Battery Charger No. 2
30A
kWH
Customer Furnished
Main 117V 60-Hz Input
40 °C (104 °F)
S1
60 °C (140 °F)
Wht
Blk
Fan
C2
1 µF
Fan
3
4
2
1
S1
40 °C (104 °F)
72 °C (162 °F)
Brn
Wht
Wht
Blk
Yel
S2
Wht
(13 °C) (55 °F)
(3 °C) (37 °F)
Blu
VENTED
S8
CLOSED
Grn
Blk
S7
13 °C (55 °F)
3 °C (37 °F)
Red
Wht
Wht
220W Heater
Blk
Brn
(Eight 500Ω 50 watt parallel resistors)
Detail B. Prior to 55910-M2, Issue 4
CB3
10A
6
5
4
MAIN
CB1
15A
9
8
AUX EQPT
CB2
7
15A
16
K1
Lightning Protector 2000V
483Ω

Figure 10-7. 910A Housing Assembly, Circuit Diagram (Sheet 6 of 8)

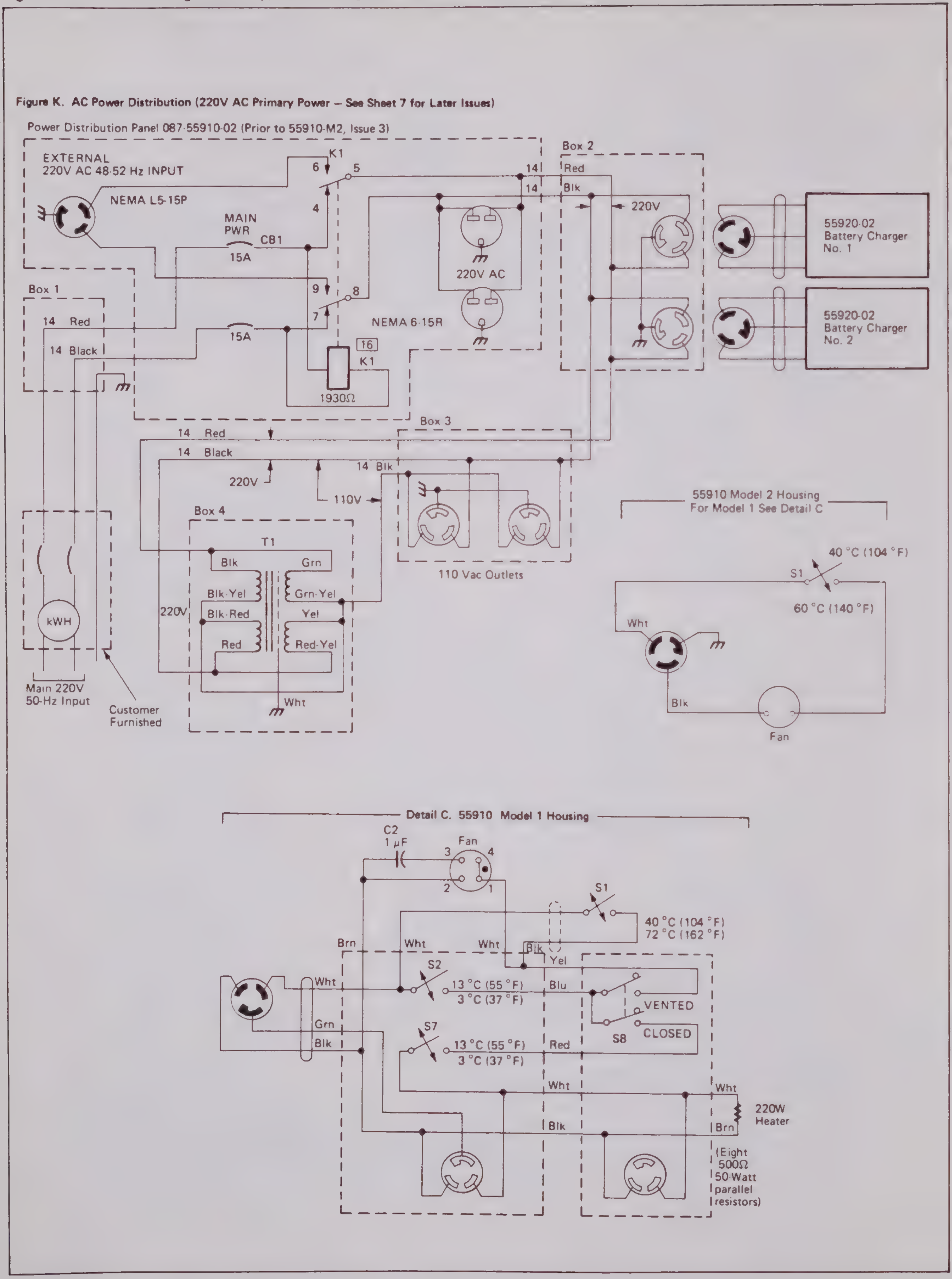


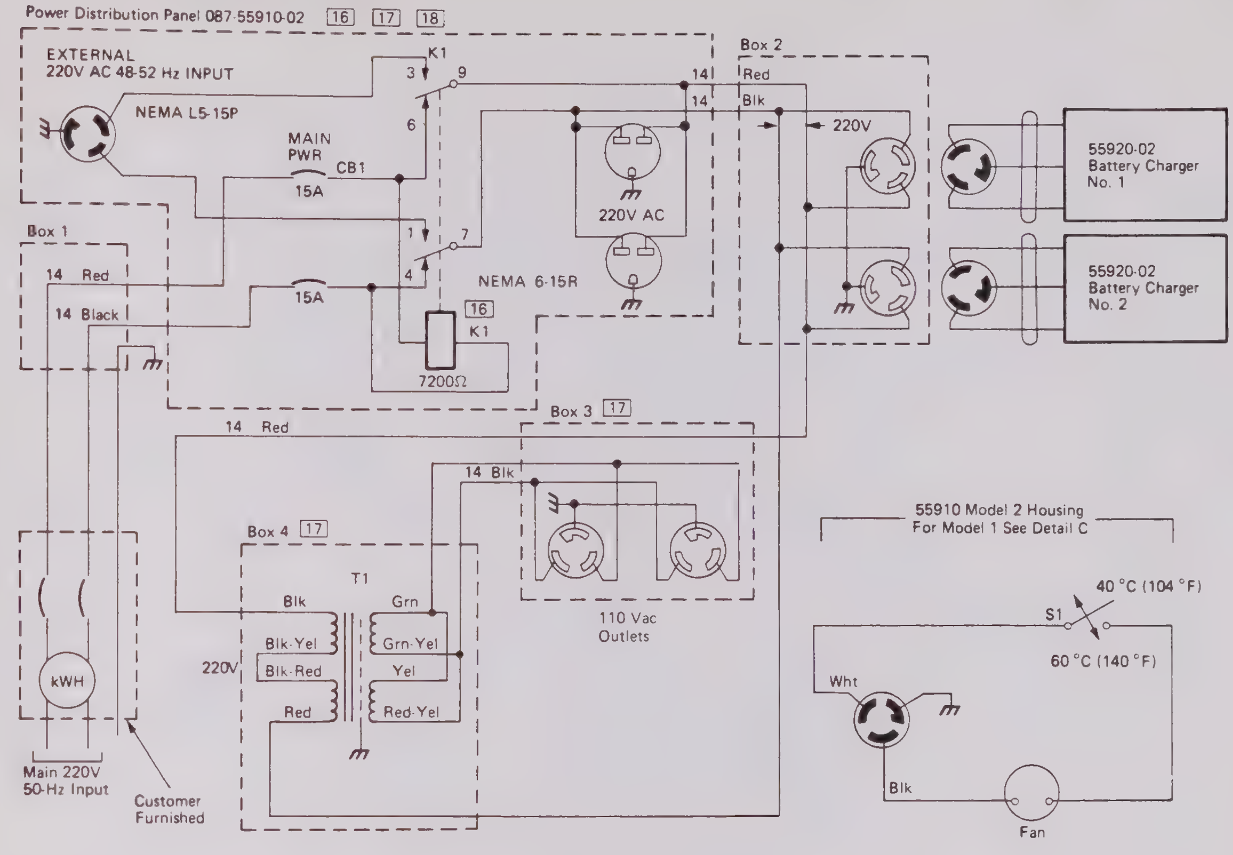
Figure K. AC Power Distribution (220V AC Primary Power – See Sheet 7 for Later Issues)

Power Distribution Panel 087-55910-02 (Prior to 55910-M2, Issue 3)

EXTERNAL
220V AC 48-52 Hz INPUT
NEMA L5-15P
K1
6
5
4
MAIN
PWR
CB1
15A
9
8
7
15A
16
K1
1930Ω
14
14
Red
Blk
Box 2
220V
220V AC
NEMA 6-15R
55920-02
Battery Charger
No. 1
55920-02
Battery Charger
No. 2
Box 1
14 Red
14 Black
14 Red
14 Black
220V
14 Blk
110V
Box 3
110 Vac Outlets
Box 4
T1
Blk
Grn
Blk-Yel
Grn-Yel
Blk-Red
Yel
Red
Red-Yel
220V
Wht
kWH
Main 220V
50-Hz Input
Customer
Furnished
55910 Model 2 Housing
For Model 1 See Detail C
40 °C (104 °F)
S1
60 °C (140 °F)
Wht
Blk
Fan
Detail C. 55910 Model 1 Housing
C2
1 μF
Fan
3
4
2
1
S1
40 °C (104 °F)
72 °C (162 °F)
Brn
Wht
Wht
Blk
Yel
S2
13 °C (55 °F)
3 °C (37 °F)
Blu
Wht
Grn
Blk
S7
13 °C (55 °F)
3 °C (37 °F)
Red
VENTED
S8
CLOSED
Wht
Wht
220W
Heater
Blk
Brn
(Eight
500Ω
50-Watt
parallel
resistors)

Figure 10-7. 910A Housing Assembly, Circuit Diagram (Sheet 7 of 8)

Figure K. AC Power Distribution (220V AC Primary Power – See Sheet 6 for Earlier Issues)


Power Distribution Panel 087-55910-02 16 17 18
EXTERNAL
220V AC 48-52 Hz INPUT
K1
3
9
6
NEMA L5-15P
MAIN
PWR
CB1
15A
1
7
4
15A
NEMA 6-15R
16
K1
7200Ω
220V AC
14
14
Box 1
14 Red
14 Black
Box 2
Red
Blk
220V
55920-02
Battery Charger
No. 1
55920-02
Battery Charger
No. 2
14 Red
Box 3 17
14 Blk
110 Vac
Outlets
Box 4 17
T1
Blk
Grn
Blk-Yel
Grn-Yel
220V
Blk-Red
Yel
Red
Red-Yel
kWH
Main 220V
50-Hz Input
Customer
Furnished
55910 Model 2 Housing
For Model 1 See Detail C
40 °C (104 °F)
S1
60 °C (140 °F)
Wht
Blk
Fan

Notes:

16 Relay K1 changed effective with 55910 M2, Issue 4. See figure F for K1 relay alarm contacts.

17 Box 3 and 4 wiring changed effective with 55910-M2, Issue 3.

18 See sheet 6 for fan and heater circuits.

Figure 10-7. 910A Housing Assembly, Circuit Diagram (Sheet 8 of 8)

Figure L. 91101 Line Terminating Shelf, Power Distribution and Alarm Circuits

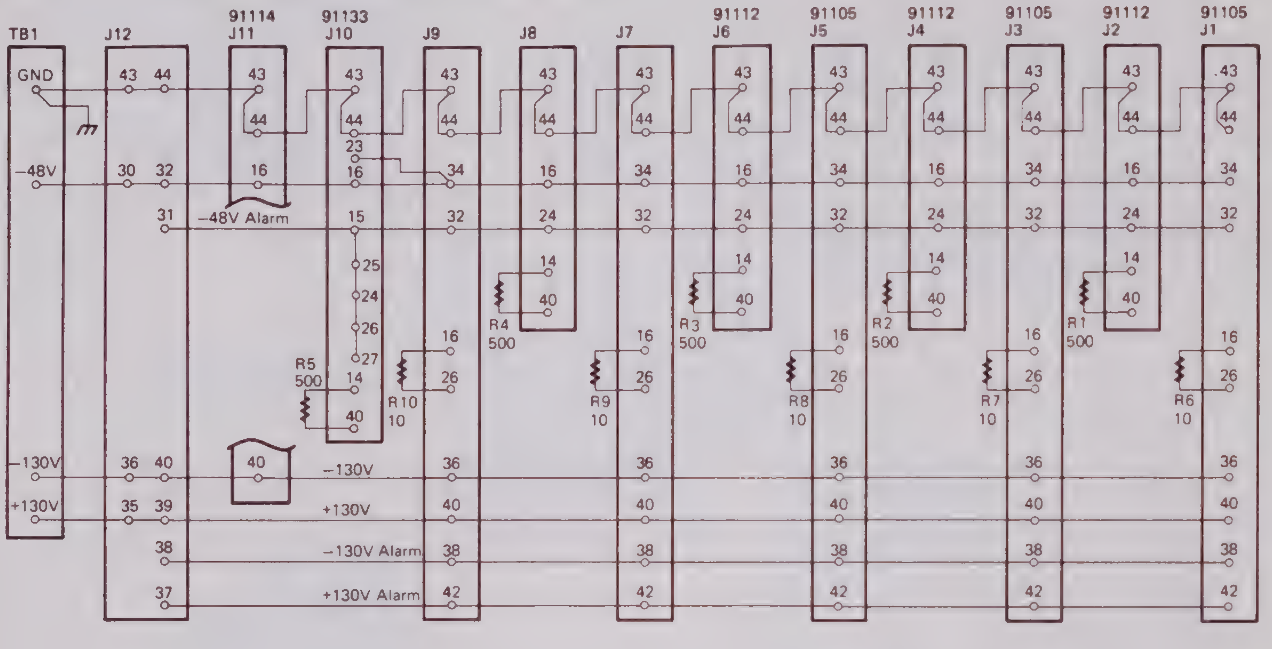

TB1
J12
91114
J11
91133
J10
J9
J8
J7
91112
J6
91105
J5
91112
J4
91105
J3
91112
J2
91105
J1
GND
−48V
−130V
+130V
−48V Alarm
−130V
+130V
−130V Alarm
+130V Alarm
R5
500
R10
10
R4
500
R9
10
R3
500
R8
10
R2
500
R7
10
R1
500
R6
10

Figure M. 55920 Battery Charger

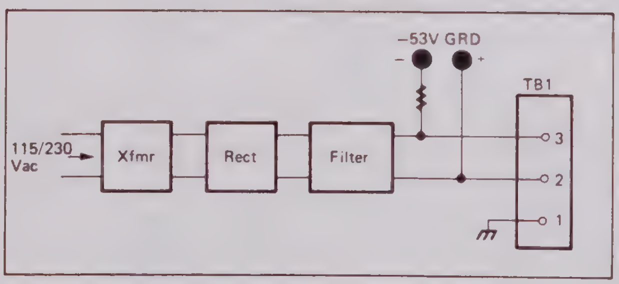

−53V GRD
−
+
TB1
115/230
Vac
Xfmr
Rect
Filter
3
2
1

Figure N. Shelf Connectors, Wiring View

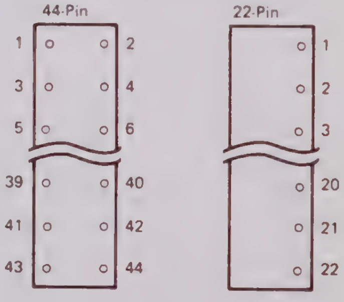
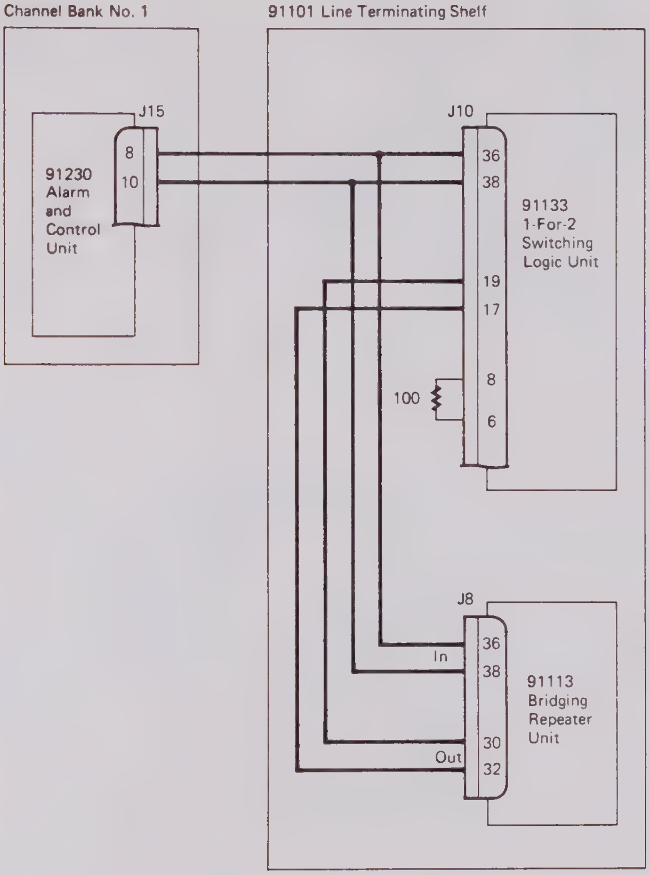

44-Pin
22-Pin
1
2
3
4
5
6
39
40
41
42
43
44
1
2
3
20
21
22

Figure 10-8. 910A Housing Assembly, Modification to Drive the Spare Line With a 91113 Bridging Repeater Unit


Channel Bank No. 1
91101 Line Terminating Shelf
J15
8
10
91230 Alarm and Control Unit
J10
36
38
19
17
8
6
100
91133 1-For-2 Switching Logic Unit
J8
36
38
In
30
32
Out
91113 Bridging Repeater Unit

Notes:

1. Modification Purpose. When the system is not engineered for fault locating both directions from the central office, the spare line must be driven from both ends instead of being looped back at the remote terminal.

2. 91101 Shelf Wiring Modifications.

   a. Remove existing jumpers J10-6 to -17 and J1-8 to -19.

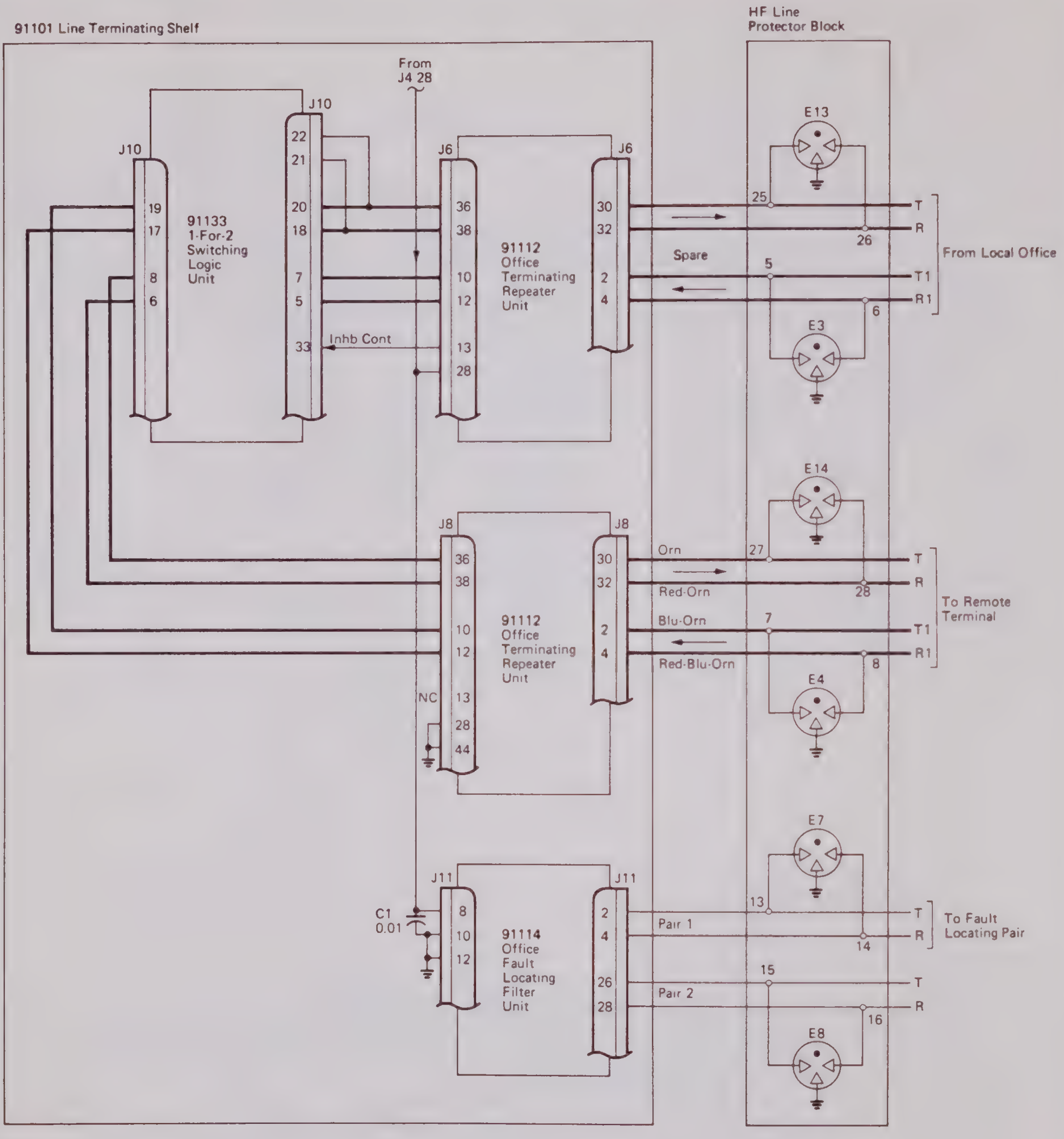
   b. Install these jumpers from J8 to J10:

      J8-36 to J10-36
      J8-38 to J10-38
      J8-30 to J10-19
      J8-32 to J10-17

   c. Connect a 100-ohm ±5%, 1/2-watt resistor from J10-6 to J10-8.

3. 91113 Bridging Repeater Unit. Install a 91113 unit in position J8 of the 91101 shelf.

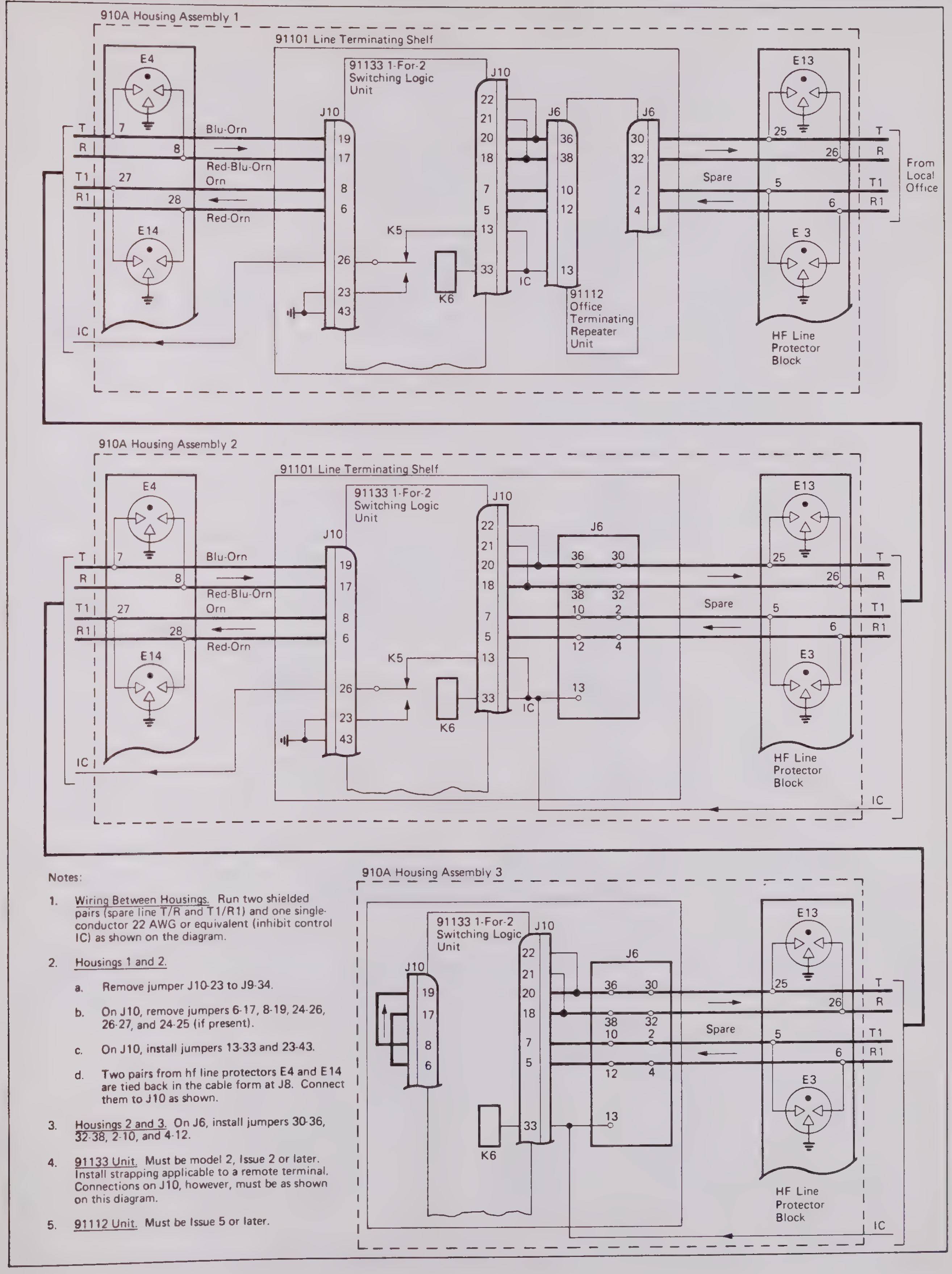
Figure 10-9. 910A Housing Assembly, Modification at an Intermediate Location for Operation With Quasi-Sectional Spare Line Switching


91101 Line Terminating Shelf
HF Line Protector Block
From J4 28
J10
J10
22
21
20
18
7
5
33
19
17
8
6
91133 1-For-2 Switching Logic Unit
Inhb Cont
J6
J6
36
38
10
12
13
28
30
32
2
4
91112 Office Terminating Repeater Unit
Spare
E13
E3
25
26
5
6
T
R
T1
R1
From Local Office
E14
E4
J8
J8
36
38
10
12
NC
13
28
44
30
32
2
4
91112 Office Terminating Repeater Unit
Orn
Red-Orn
Blu-Orn
Red-Blu-Orn
27
28
7
8
T
R
T1
R1
To Remote Terminal
E7
E8
J11
J11
C1 0.01
8
10
12
2
4
26
28
91114 Office Fault Locating Filter Unit
Pair 1
Pair 2
13
14
15
16
T
R
T
R
To Fault Locating Pair

Notes:

1. 91101 Shelf Wiring Modifications
   a. Two pairs from hf line protectors E4 and E14 are tied back in the cable form at J8. Connect them to J8 as shown on the diagram.
   b. Remove existing jumpers J10-6 to -17 and J10-8 to -19. Connect these pins on J10 to J8 as shown on the diagram.
   c. Ground the fault locating output of the 91112 repeater unit by connecting J8-28 to -44.
2. 91112 Repeater Unit. Install an additional 91112 repeater unit in position J8 of the 91101 shelf.
3. 91133 Unit Strapping. Install strapping applicable to a remote terminal. Connections to J10, however, must be as shown on this diagram.

Figure 10-10. 910A Housing Assembly, Modification of Colocated Housing at a Remote Location for Operation With Quasi-Sectional Spare Line Switching


910A Housing Assembly 1
91101 Line Terminating Shelf
91133 1-For-2 Switching Logic Unit
J10
J10
J6
J6
E4
E14
E13
E 3
T
R
T1
R1
7
8
27
28
Blu-Orn
Red-Blu-Orn
Orn
Red-Orn
19
17
8
6
26
23
43
22
21
20
18
7
5
13
33
36
38
10
12
13
30
32
2
4
K5
K6
IC
91112 Office Terminating Repeater Unit
Spare
25
26
5
6
HF Line Protector Block
From Local Office
910A Housing Assembly 2
91101 Line Terminating Shelf
91133 1-For-2 Switching Logic Unit
J10
J6
36
30
38
32
10
2
12
4
13
HF Line Protector Block
IC
910A Housing Assembly 3
91133 1-For-2 Switching Logic Unit
J10
J6
K6
Spare
HF Line Protector Block
IC

Notes:

1. Wiring Between Housings. Run two shielded pairs (spare line T/R and T1/R1) and one single-conductor 22 AWG or equivalent (inhibit control IC) as shown on the diagram.

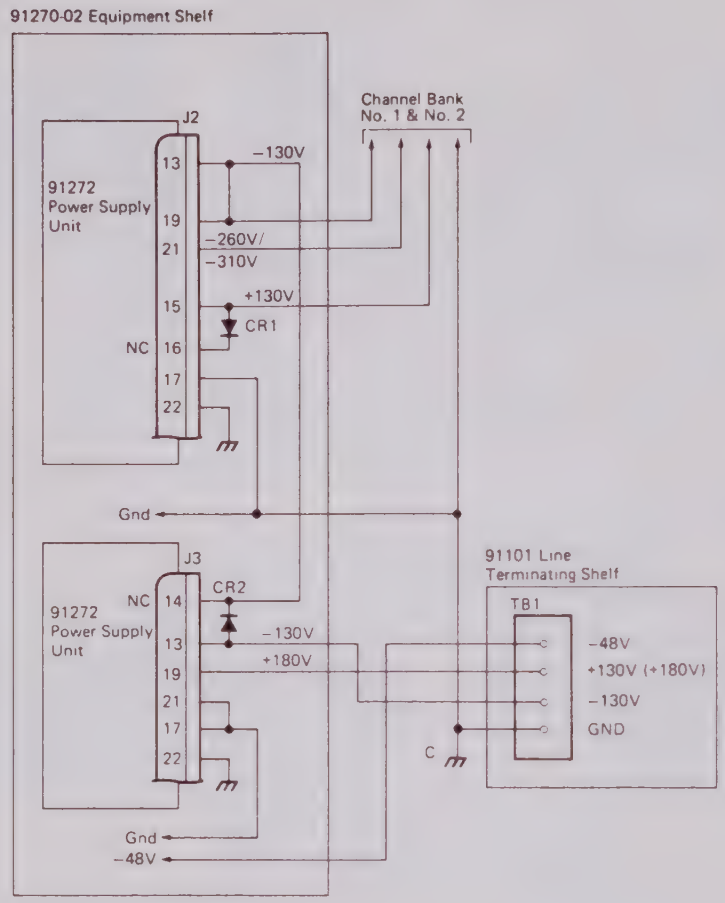
2. Housings 1 and 2.
   - a. Remove jumper J10-23 to J9-34.
   - b. On J10, remove jumpers 6-17, 8-19, 24-26, 26-27, and 24-25 (if present).
   - c. On J10, install jumpers 13-33 and 23-43.
   - d. Two pairs from hf line protectors E4 and E14 are tied back in the cable form at J8. Connect them to J10 as shown.

3. Housings 2 and 3. On J6, install jumpers 30-36, 32-38, 2-10, and 4-12.

4. 91133 Unit. Must be model 2, Issue 2 or later. Install strapping applicable to a remote terminal. Connections on J10, however, must be as shown on this diagram.

5. 91112 Unit. Must be Issue 5 or later.

Figure 10-11. 910A Housing Assembly, Modification to Supply Span Power at 310V (– 130V and + 180V)


91270-02 Equipment Shelf
J2
91272
Power Supply
Unit
13
19
21
15
NC
16
17
22
–130V
–260V/
–310V
+130V
CR1
Channel Bank
No. 1 & No. 2
Gnd
J3
91272
Power Supply
Unit
NC
14
13
19
21
17
22
CR2
–130V
+180V
Gnd
–48V
91101 Line
Terminating Shelf
TB1
–48V
+130V (+180V)
–130V
GND
C

Notes:

1. Modification Description. To obtain span power at 310V, the 180V output at pins 19 and 21 of the 91272 Power Supply Unit in position J3 of the 91270 shelf is utilized instead of the 130V output at pins 15 and 17.

2. 91270 Shelf Wiring Modifications.

   a. Remove existing jumper J2-16 to J3-15.

   b. Install a jumper from J3-17 to -21.

   c. Transfer the lead coming from +130V terminal on TB1 of the 91101 shelf from J3-15 to -19 on the 91270 shelf.

3. 91272 Unit Strapping. Strap terminals 207-208 instead of 208-209.

Figure 10-12. Troubleshooting Chart For Equipment Alarms (Sheet 1 of 2)

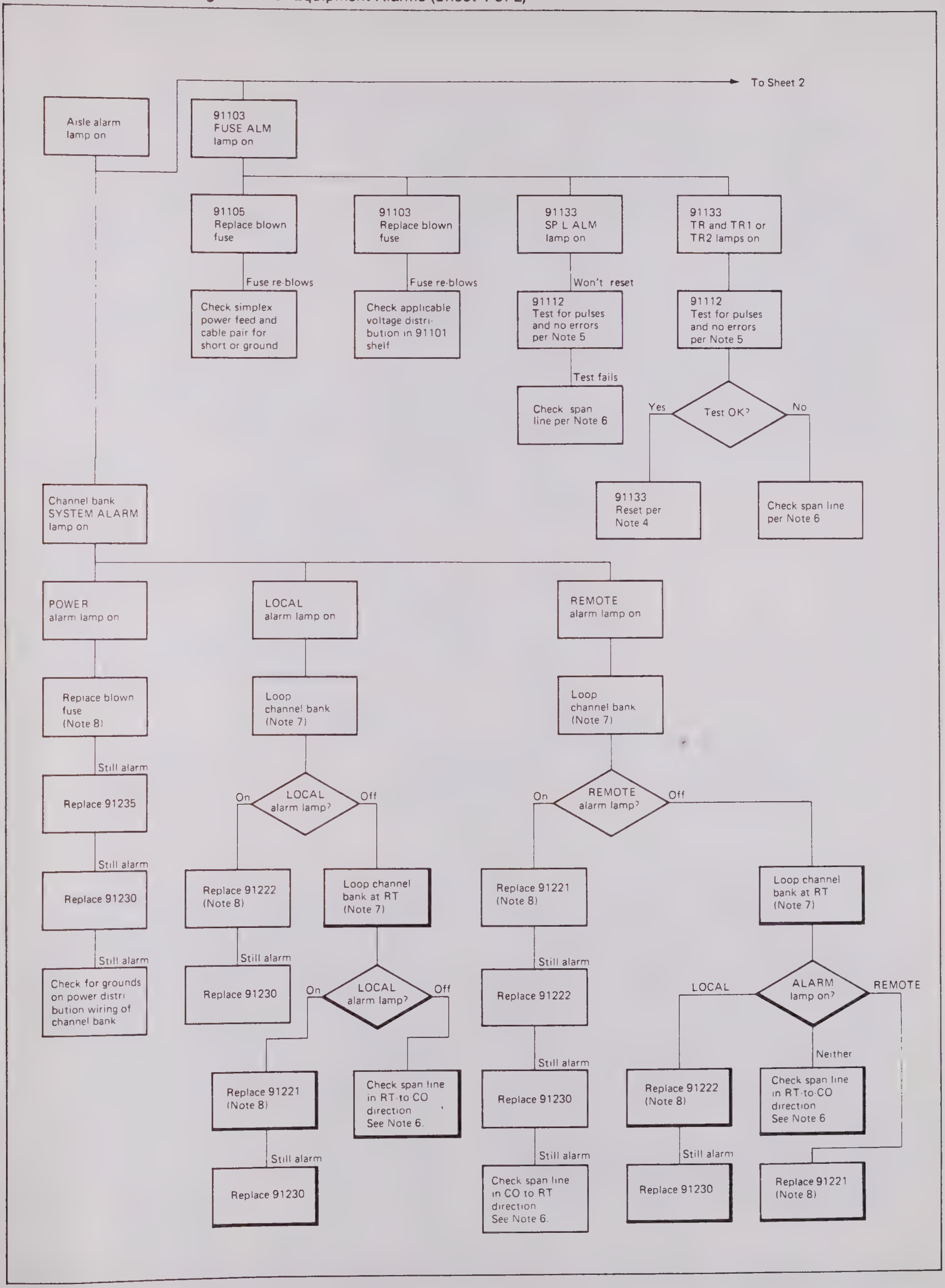
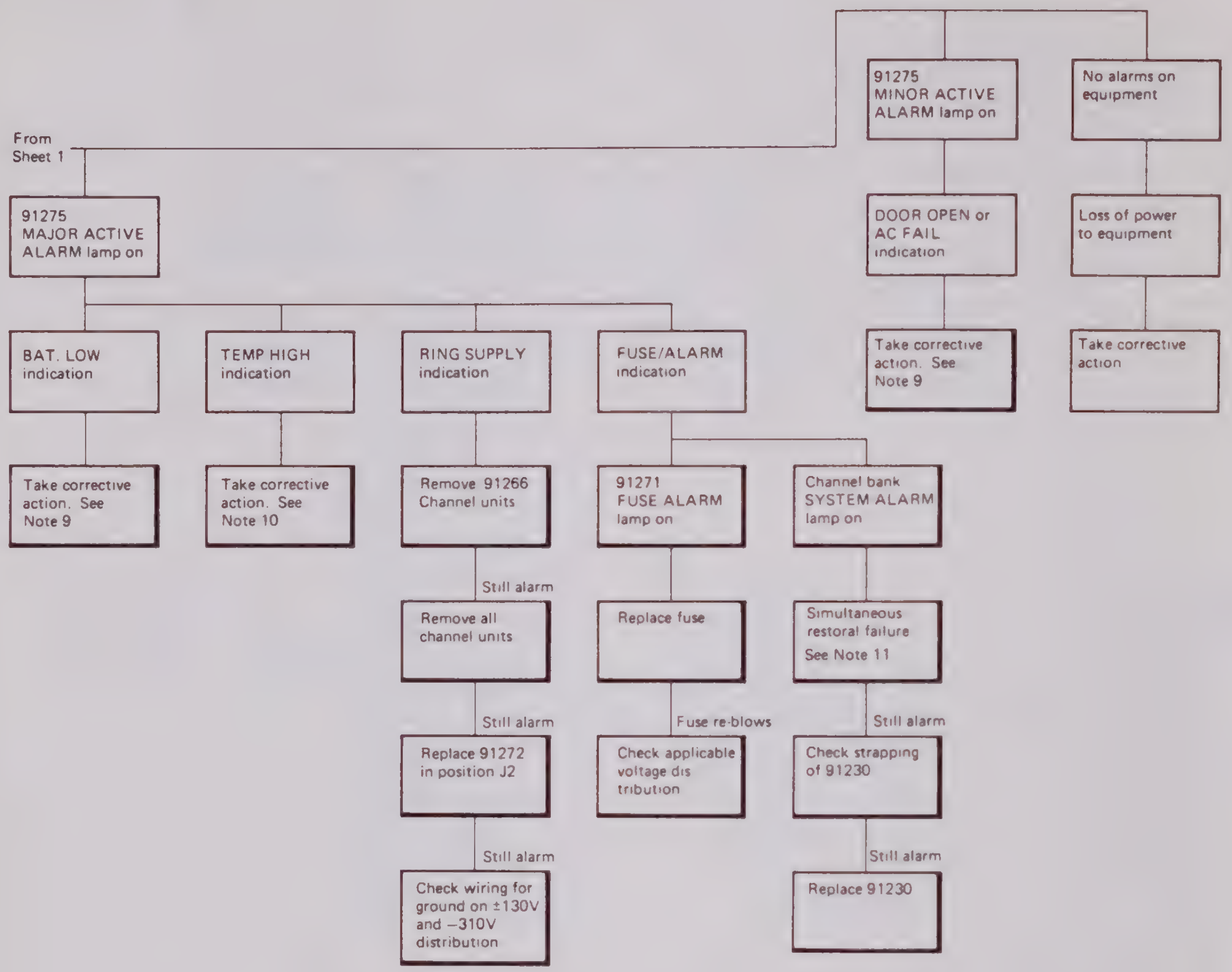

To Sheet 2
Aisle alarm lamp on
91103 FUSE ALM lamp on
91105 Replace blown fuse
Fuse re-blows
Check simplex power feed and cable pair for short or ground
91103 Replace blown fuse
Fuse re-blows
Check applicable voltage distribution in 91101 shelf
91133 SP L ALM lamp on
Won't reset
91112 Test for pulses and no errors per Note 5
Test fails
Check span line per Note 6
91133 TR and TR1 or TR2 lamps on
91112 Test for pulses and no errors per Note 5
Test OK?
Yes
No
91133 Reset per Note 4
Check span line per Note 6
Channel bank SYSTEM ALARM lamp on
POWER alarm lamp on
Replace blown fuse (Note 8)
Still alarm
Replace 91235
Still alarm
Replace 91230
Still alarm
Check for grounds on power distribution wiring of channel bank
LOCAL alarm lamp on
Loop channel bank (Note 7)
LOCAL alarm lamp?
On
Off
Replace 91222 (Note 8)
Still alarm
Replace 91230
Loop channel bank at RT (Note 7)
LOCAL alarm lamp?
On
Off
Replace 91221 (Note 8)
Still alarm
Replace 91230
Check span line in RT-to CO direction See Note 6.
REMOTE alarm lamp on
Loop channel bank (Note 7)
REMOTE alarm lamp?
On
Off
Replace 91221 (Note 8)
Still alarm
Replace 91222
Still alarm
Replace 91230
Still alarm
Check span line in CO to RT direction See Note 6.
Loop channel bank at RT (Note 7)
ALARM lamp on?
LOCAL
REMOTE
Neither
Replace 91222 (Note 8)
Still alarm
Replace 91230
Check span line in RT-to-CO direction See Note 6
Replace 91221 (Note 8)

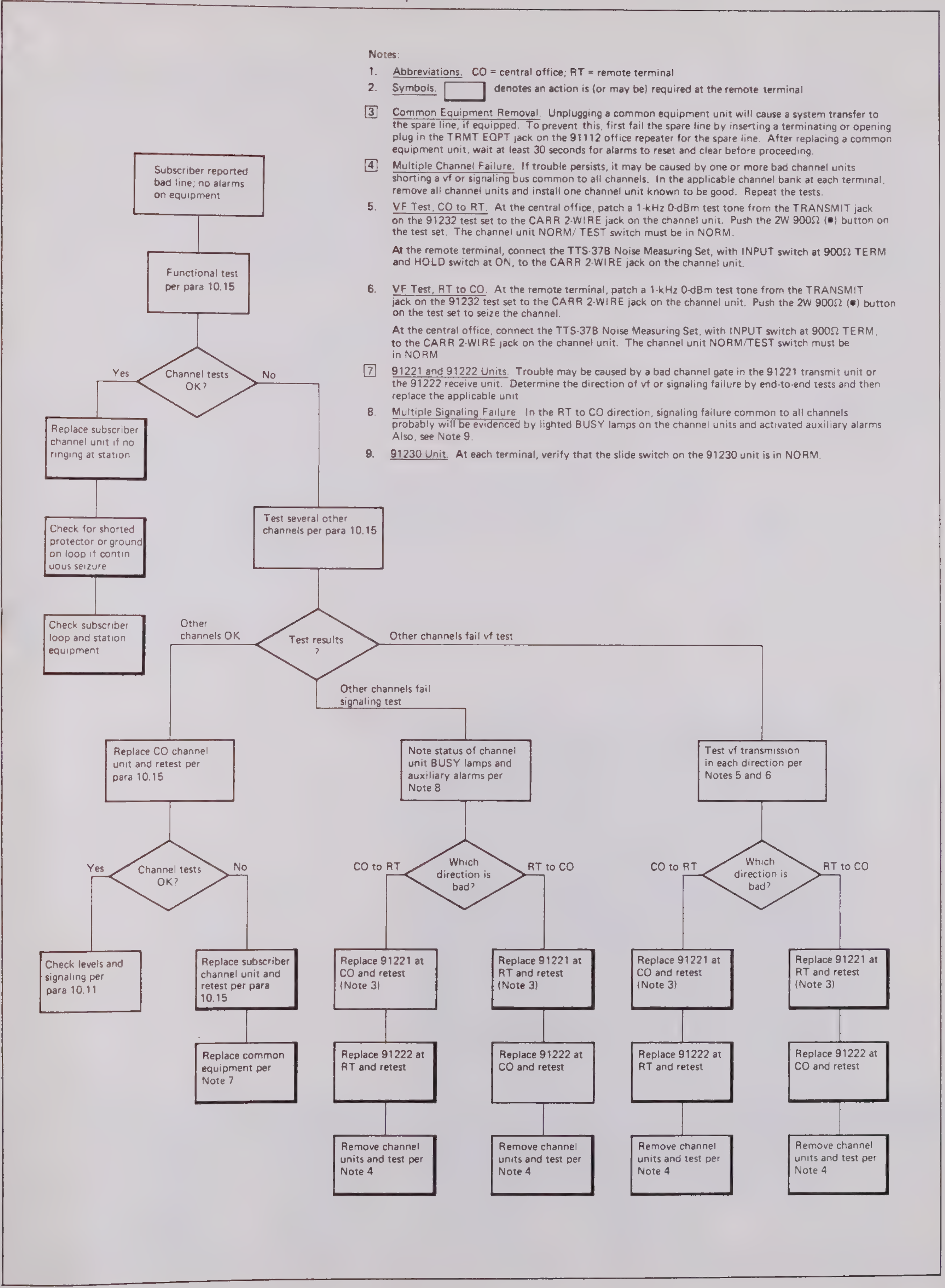
Figure 10-12. Troubleshooting Chart For Equipment Alarms (Sheet 2 of 2)


From Sheet 1
91275 MINOR ACTIVE ALARM lamp on
No alarms on equipment
DOOR OPEN or AC FAIL indication
Loss of power to equipment
Take corrective action. See Note 9
Take corrective action
91275 MAJOR ACTIVE ALARM lamp on
BAT. LOW indication
TEMP HIGH indication
RING SUPPLY indication
FUSE/ALARM indication
Take corrective action. See Note 9
Take corrective action. See Note 10
Remove 91266 Channel units
91271 FUSE ALARM lamp on
Channel bank SYSTEM ALARM lamp on
Still alarm
Remove all channel units
Replace fuse
Simultaneous restoral failure See Note 11
Still alarm
Fuse re-blows
Still alarm
Replace 91272 in position J2
Check applicable voltage distribution
Check strapping of 91230
Still alarm
Still alarm
Check wiring for ground on ±130V and −310V distribution
Replace 91230

Notes:

1. Abbreviations. CO = central office; RT = remote terminal
2. Symbols. ▭ denotes an action is (or may be) required at the remote terminal.
3. Logic. Troubleshooting logic is based on a 910A system equipped with spare line switching and error detectors on the office repeaters (91112-02).
4. Spare Line Reset. To reset the 91133 unit after a working system has transferred to the spare line, press TR RESET button. Red indicators on the 91133 unit should go out.
5. Error Detectors. On the applicable 91112-02 unit, check for incoming pulses by pressing button. Red lamp should light. With button released, if lamp lights continuously or flashes more than once per second, span line is failed.
6. Span Line Troubleshooting. Refer to Section 342-910-103.
7. Channel Bank HF Loopback. To loop the hf signal from the channel bank, push ACO button and then LOOP button on 91230 unit. Both ACO and LOOP indicators must light. To restore to normal from loopback mode, again push LOOP button. LOOP lamp should go out. ACO lamp will stay lighted until alarms clear.
8. Common Equipment Removal. Unplugging a common equipment unit will cause a system transfer to the spare line, if equipped. To prevent this, first fail the spare line by inserting a terminating or opening plug in the TRMT EQPT jack on the 91112 office repeater for the spare line. After replacing a common equipment unit, wait at least 30 seconds for alarms to reset and clear before proceeding.
9. AC Power Failure. Six hours or less after an ac power failure, battery voltage will have decreased to 44 volts, activating the BAT. LOW auxiliary alarm. (At this voltage there may be dialing failures on loops exceeding 1200 ohms.) After an additional 2 hours or less, battery voltage will have decreased to 36 volts and dc power to the terminal equipment will be shut off.
10. Housing Temperature. The thermostat controlling the TEMP HIGH auxiliary alarm operates at 176°F. When this alarm occurs, failure to take corrective action may result in operation of the overheat thermostat, which will cut off dc power to the terminal equipment. The operating point of the overheat thermostat is also 176°F, but it is located lower in the housing than the alarm thermostat and, because of the vertical temperature gradient in the housing, will operate later.
11. Simultaneous Restoral. On some early versions of the 9002A channel bank, channel 12 must be equipped to enable simultaneous restoral from system alarm at both terminals.

Figure 10-13. Troubleshooting Chart for Subscriber Complaints


Subscriber reported bad line; no alarms on equipment
Functional test per para 10.15
Channel tests OK?
Yes
No
Replace subscriber channel unit if no ringing at station
Check for shorted protector or ground on loop if continuous seizure
Check subscriber loop and station equipment
Test several other channels per para 10.15
Test results ?
Other channels OK
Other channels fail vf test
Other channels fail signaling test
Replace CO channel unit and retest per para 10.15
Note status of channel unit BUSY lamps and auxiliary alarms per Note 8
Test vf transmission in each direction per Notes 5 and 6
Channel tests OK?
Yes
No
Check levels and signaling per para 10.11
Replace subscriber channel unit and retest per para 10.15
Replace common equipment per Note 7
Which direction is bad?
CO to RT
RT to CO
Replace 91221 at CO and retest (Note 3)
Replace 91222 at RT and retest
Remove channel units and test per Note 4
Replace 91221 at RT and retest (Note 3)
Replace 91222 at CO and retest
Remove channel units and test per Note 4
Which direction is bad?
CO to RT
RT to CO
Replace 91221 at CO and retest (Note 3)
Replace 91222 at RT and retest
Remove channel units and test per Note 4
Replace 91221 at RT and retest (Note 3)
Replace 91222 at CO and retest
Remove channel units and test per Note 4

Notes:

1. Abbreviations. CO = central office; RT = remote terminal
2. Symbols. ☐ denotes an action is (or may be) required at the remote terminal
3. Common Equipment Removal. Unplugging a common equipment unit will cause a system transfer to the spare line, if equipped. To prevent this, first fail the spare line by inserting a terminating or opening plug in the TRMT EQPT jack on the 91112 office repeater for the spare line. After replacing a common equipment unit, wait at least 30 seconds for alarms to reset and clear before proceeding.
4. Multiple Channel Failure. If trouble persists, it may be caused by one or more bad channel units shorting a vf or signaling bus common to all channels. In the applicable channel bank at each terminal, remove all channel units and install one channel unit known to be good. Repeat the tests.
5. VF Test, CO to RT. At the central office, patch a 1-kHz 0-dBm test tone from the TRANSMIT jack on the 91232 test set to the CARR 2-WIRE jack on the channel unit. Push the 2W 900Ω (■) button on the test set. The channel unit NORM/ TEST switch must be in NORM.

   At the remote terminal, connect the TTS-37B Noise Measuring Set, with INPUT switch at 900Ω TERM and HOLD switch at ON, to the CARR 2-WIRE jack on the channel unit.

6. VF Test, RT to CO. At the remote terminal, patch a 1-kHz 0-dBm test tone from the TRANSMIT jack on the 91232 test set to the CARR 2-WIRE jack on the channel unit. Push the 2W 900Ω (■) button on the test set to seize the channel.

   At the central office, connect the TTS-37B Noise Measuring Set, with INPUT switch at 900Ω TERM, to the CARR 2-WIRE jack on the channel unit. The channel unit NORM/TEST switch must be in NORM

7. 91221 and 91222 Units. Trouble may be caused by a bad channel gate in the 91221 transmit unit or the 91222 receive unit. Determine the direction of vf or signaling failure by end-to-end tests and then replace the applicable unit
8. Multiple Signaling Failure In the RT to CO direction, signaling failure common to all channels probably will be evidenced by lighted BUSY lamps on the channel units and activated auxiliary alarms Also, see Note 9.
9. 91230 Unit. At each terminal, verify that the slide switch on the 91230 unit is in NORM.

GTE LENKURT

Company Headquarters and Manufacturing Facility
1105 County Road
San Carlos, California 94070
Phone 415–595-3000

Albuquerque Manufacturing Facility
One Camino de Lenkurt
Albuquerque, New Mexico 87123
Phone 505–296-0551

El Paso Manufacturing Facility
10727 Gateway West
El Paso, Texas 79935
Phone 915–593 3400

District Sales Offices
1105 County Road
San Carlos, California 94070
Phone 415– 595 3000

120 West Eastman Street
Arlington Heights, Illinois 60004
Phone 312–398 6700

542 Haggard Street, Suite 510
Plano, Texas 75074
Phone 214–422-4305

3015 Williams Drive
Fairfax, Virginia 22031
Phone 703–698-1850

5780 Peachtree-Dunwoody Road, N E
Suite 145
Atlanta, Georgia 30342
Phone 404–256 3000

GTE International Sales Office
1105 County Road
San Carlos, California 94070
Phone 415–595 3000
Cable. GENTELINT

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Engineering—Plant Series
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Section 342—911—107
Issue 3, July, 1979

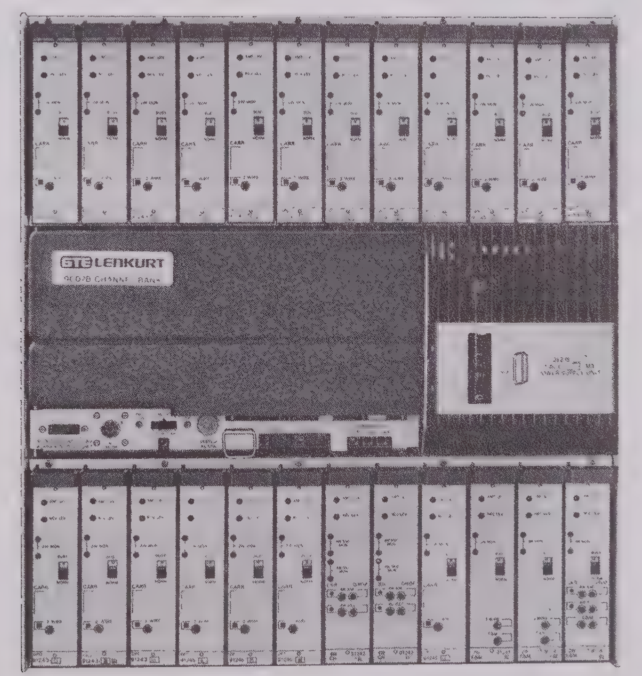
9002B PCM Channel Bank

APPLICATIONS

- Multiplex up to 24 voice channels for high-quality, toll-grade transmission.
- Ideal for voice and data communications in toll, toll-connecting, exchange, subscriber and paystation applications.
- Four basic signaling options: E&M, loop dial, foreign exchange and subscriber.
- Toll, exchange, and subscriber channel units may be intermixed in the same channel bank for equipment economy and wide flexibility in special service applications.

FEATURES

- End-to-end compatible with GTE Lenkurt 9002A and 9004A and Western Electric D1D, D2, D3 and D4 type equipment.
- D2 or D1D channel sequence selected by a plug-in adapter. D3 sequence provided as standard.
- Standard DS1 (1.544 Mb/s) line signal.
- Integrated and thick-film circuitry throughout — ensures reliability, long life, low-cost service and maintenance free operation.
- Only four common equipment units.
- Optional connectorized vf and signaling connections speed installation and reduce wiring errors.
- Channel bank available in standard, factory-wired rack arrangements or as loose equipment.
- Alarm response mode strappable for fast or slow (Bell System Standard) sequence.
- Transmit timing can be strapped for internal clock, looped receive clock or external clock operation.
- Provides muting during frame search.
- Optional on-hook or off-hook channel conditioning during alarm sequence.
- Immune to false framing.
- Built-in coder and decoder alarms.



9002B
PCM Channel Bank

TECHNICAL SUMMARY

VF Channels		
Number	24	
Levels		
Two-wire	0 dBm transmit; —3 dBm receive	
Four-wire	—16 dBm transmit; +7 dBm receive	
Receive level stability (3-month period)	Less than 0.5 dB distribution grade	
Bandwidth (3-dB points referenced to 1 kHz)		
Two-wire	250 to 3400 Hz	
Four-wire	200 to 3400 Hz	
Impedance		
Two-wire	600 or 900 ohms plus 2.15 μF	
Four-wire	600 ohms	
Echo return loss		
Intertoll and foreign-exchange	28 dB minimum; 33 dB typical	
Toll-connecting and subscriber	22 dB minimum; 26 dB typical	
Delay distortion	Frequency	Envelope delay
	1150 to 2300 Hz	Less than 65 μs
	1000 to 2500 Hz	Less than 115 μs
	800 to 2700 Hz	Less than 225 μs
Interchannel crosstalk	Less than 25 dBrnc0	
Idle noise (all channels terminated)	23 dBrnc0 maximum; 16 dBrnc0 typical	
Impulse noise (DS1 looped back)	Threshold, voice-band weighting	Maximum counts in 30 minutes
	41 dBrn	10
	51 dBrn	1
	58 dBrn	0.1
High-performance data option compatibility (HPDO)		
C-notched noise ADL - 201	28 dBr~~nc~~0	
Nonlinear distortion ratio		
Fundamental to second order products	35 dB	
Fundamental to third order products	40 dB	
Harmonic distortion ratio		
Fundamental to second harmonic	33 dB	
Fundamental to third harmonic	38 dB	
DS1 Interface		
Line rate	1.544 Mb/s ±200 b/s	
Line code	Bipolar	
Transmit pulse characteristics		
Base-to-peak height	6 volts ±10% into a 6-dB pad or cable equalizer on the 91230 unit	
Unbalance in height of positive and negative pulses	±0.3 volt	
Half-amplitude width	324 ±30 ns	
Unbalance in width of positive and negative pulses	±15 ns	
Maximum rise or fall time	80 ns	
Minimum density	Normally 1 in 8; not more than 15 consecutive zeros	
Receive pulse amplitude, base-to-peak	1.5 to 3 volts	
Line impedance	100 ohms nominal	
Compatibility	End-to-end compatible with Western Electric D1D, D2, D3, and D4 channel banks, T1-type span lines, and 9122A (M1C) multiplexers	
DS1 Signal Format		
Frame organization	24 eight-bit channel pcm words plus one framing bit (193 bits total)	
Channel pcm word (12-frame interval)		
Frames 1 through 5	Eight vf information bits	
Frame 6	Seven vf information bits and one "A" signaling bit	
Frames 7 through 11	Eight vf information bits	
Frame 12	Seven vf information bits and one "B" signaling bit	
Framing bit pattern (12-frame interval)		
Terminal framing bit t	101010 in odd-numbered frames 1 thru 11	
Signaling framing bit 9	001110 in even-numbered frames 2 thru 12	
Signaling on vf channels		
Signaling channels	Two (A and B)	
Bit rate	1333 b/s (666 b/s on A and B)	
Coder-decoder (Codec)		
Codec type	Companding	
Compression law	Approximates $\mu = 255$ law	
Coding method	Successive approximation	

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Addendum 342—911—107
Issue 1, April 1981

9002B PCM Channel Bank

1. GENERAL

1.01 This Addendum to Section 342-911-107, Issue 3, adds an -02 option to the 91230 Model 3 Alarm and Control Unit. Miscellaneous other changes are made.

1.02 In ink or red pencil make the changes described in Part 2 or write "See Addendum" in the margin adjacent to each change. File this Addendum directly in front of Section 342-911-107, Issue 3.

---

2. CHANGES

● 2.01 Page 2, Technical Summary, change "C-notched noise" to read "Test tone to C-notched noise ratio" and change "28 dBrnc0" to read "28 dB."

● 2.02 Page 3, Technical Summary, under "Equipment" change "91220" to read "91330."

● 2.03 Page 15, paragraph 3.54, replace with new paragraph: The 91230 Alarm and Control Unit monitors (1) output voltages of the power supply unit, (2) synchronization of the local receive unit with the remote transmit unit, (3) status of bit 2 in the incoming pcm channel words, and (4) bit error rate (-02 option only). The 91230-02 option is provided for common control applications; a seriously degraded (average bit error rate of 10^{-3}) repeatered line or digital facility is immediately detected and a local/system alarm initiated. This feature is called an 8:1 ratio hit integration detector. The unit also includes circuits for setting up various channel bank test modes and, at the ALIGN connector, an interface with the 91232 test set. Alarm conditions or test conditions are identified by lighted indicators on the alarm unit and by office alarms controlled by relays on the alarm unit.

● 2.04 Page 15, add new paragraph 3.57a.

3.57a The bit error rate detector in the 91230-02 option monitors the incoming AC-1 signal for framing bit errors. A framing bit in error counts +8, a framing bit not in error counts −1. At a bit error rate of 10^{-3}, the positive threshold will be exceeded and, after a 50- or 300-ms delay, the local alarm will take place.

● 2.05 Pages 16 and 17, replace figure 3-8 (both sheets) with new figure 3-8 showing 91230-02 option and strapping plugs.

● 2.06 Page 27, figure 4-1 in Type column, add "91238 No. 2 EAX" below 91237 2W DX. In mA/Unit column opposite 91238 add "65." In mA/Unit column opposite 91255-01 change "28" to "41." In Total Current, mA column move "3.56A" down into bottom "Total" box.

● 2.07 Page 29, add new paragraphs 4.33a and 4.33b.

4.33a The 91230-01 unit will not cause frequent system alarms because of a marginal repeatered line. A resulting disadvantage is that a seriously degraded repeatered line can cause a common control office to become overloaded by an excessive number of incoming register sender seizures.

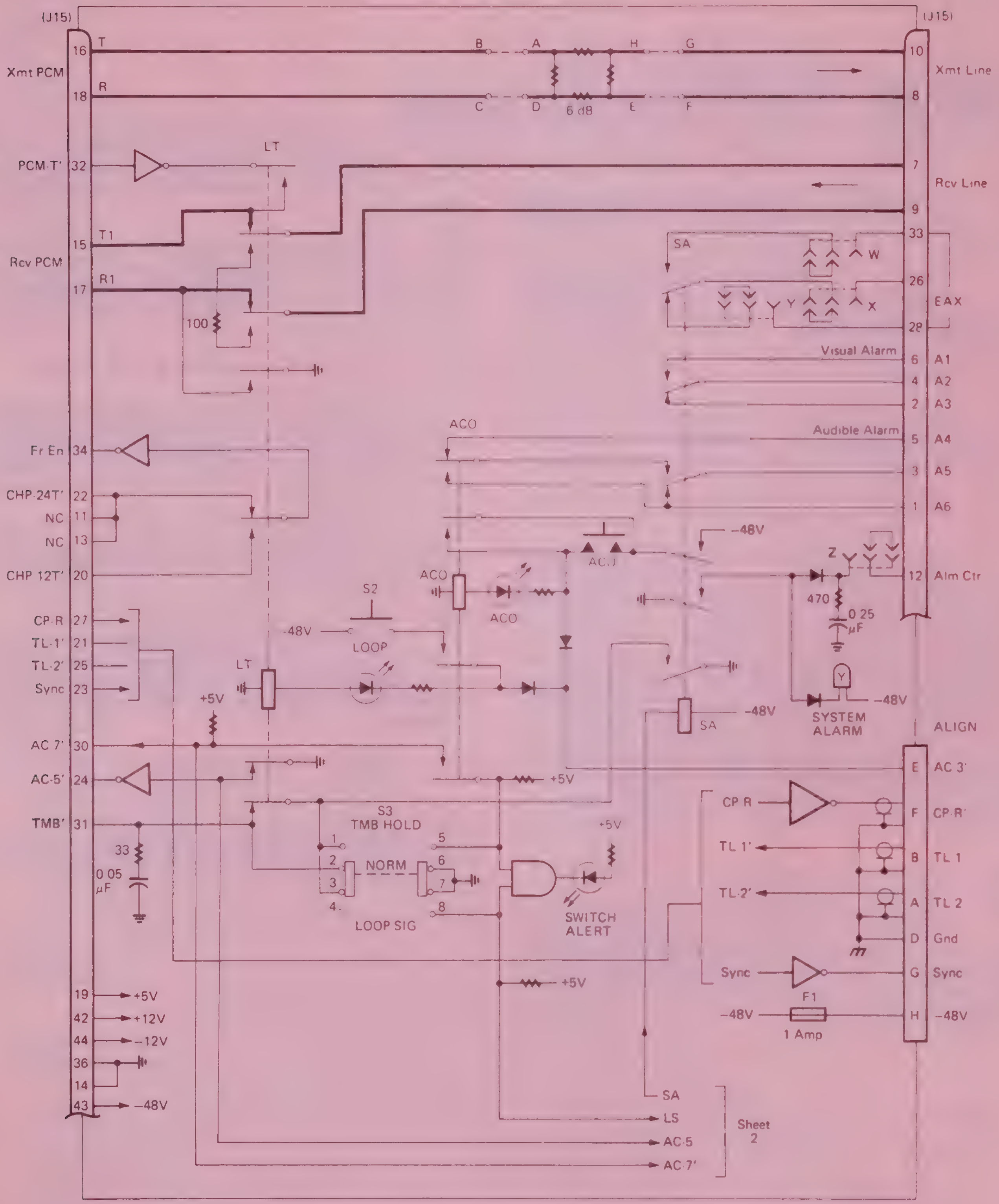
4.33b The 91230-02 unit may be used for common control applications. A seriously degraded (average bit error rate of 10^{-3}) repeatered line is immediately detected and a local/system alarm initiated.

● 2.08 Page 30, figure 5-1, in Type No. column add "-02" under the 91230-01 and add the following description for it in the Description column: "Same as -01 except equipped with a subassembly which provides a local/system alarm when the bit error rate approaches a 10^{-3} rate. For common control applications."

● 2.09 Page 32, figure 5-3, change "792B Cord" to read "729B Cord" in Test Equipment column.

● 2.10 Page 34, figure 6-1, in Ordering Number 91300-XX column add "-05" under the -04. In Description column opposite the -05 add "Same as -02 except 91230 Alarm and Control Unit is -02 option."

Figure 3-8. 91230 Alarm and Control Unit Circuit Diagram (Sheet 1 of 2)


(J15)
(J15)
Xmt PCM
16
T
18
R
B
A
H
G
C
D
6 dB
E
F
10
8
Xmt Line
PCM-T'
32
LT
7
Rcv Line
9
Rcv PCM
15
T1
17
R1
100
33
SA
W
26
EAX
Y
X
28
Visual Alarm
6
A1
4
A2
2
A3
ACO
Audible Alarm
5
A4
3
A5
1
A6
Fr En
34
CHP-24T'
22
NC
11
NC
13
CHP 12T'
20
-48V
Z
12
Alm Ctr
ACO
S2
470
0.25 µF
CP-R
27
TL-1'
21
TL-2'
25
Sync
23
-48V
LOOP
ACO
LT
Y
-48V
SYSTEM ALARM
-48V
SA
+5V
ALIGN
AC 7'
30
AC-5'
24
+5V
E
AC 3'
TMB'
31
S3
TMB HOLD
CP R
F
CP-R'
+5V
33
1
5
TL 1'
B
TL 1
0.05 µF
2
NORM
6
3
7
TL-2'
A
TL 2
4
8
LOOP SIG
SWITCH ALERT
D
Gnd
Sync
G
Sync
+5V
F1
19
+5V
-48V
1 Amp
H
-48V
42
+12V
44
-12V
36
14
43
-48V
SA
LS
AC-5
AC-7'
Sheet 2

Notes:

1. Relays and Switches. Contacts are shown in normal operating position.
2. External Alarms. Unit is shipped with straps W, X, Y, and Z open. If EAX and alarm counter circuits are used, close the straps.
3. Strapping Plugs. Effective with 91230-M3 Issue 9, screw-straps were replaced by strapping plugs. The correspondence between the two types of straps is shown by the example of strap J below:

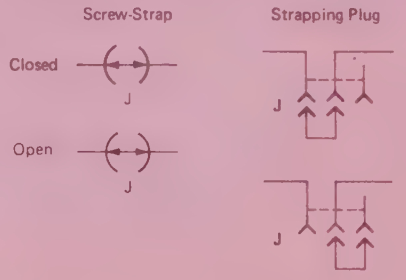
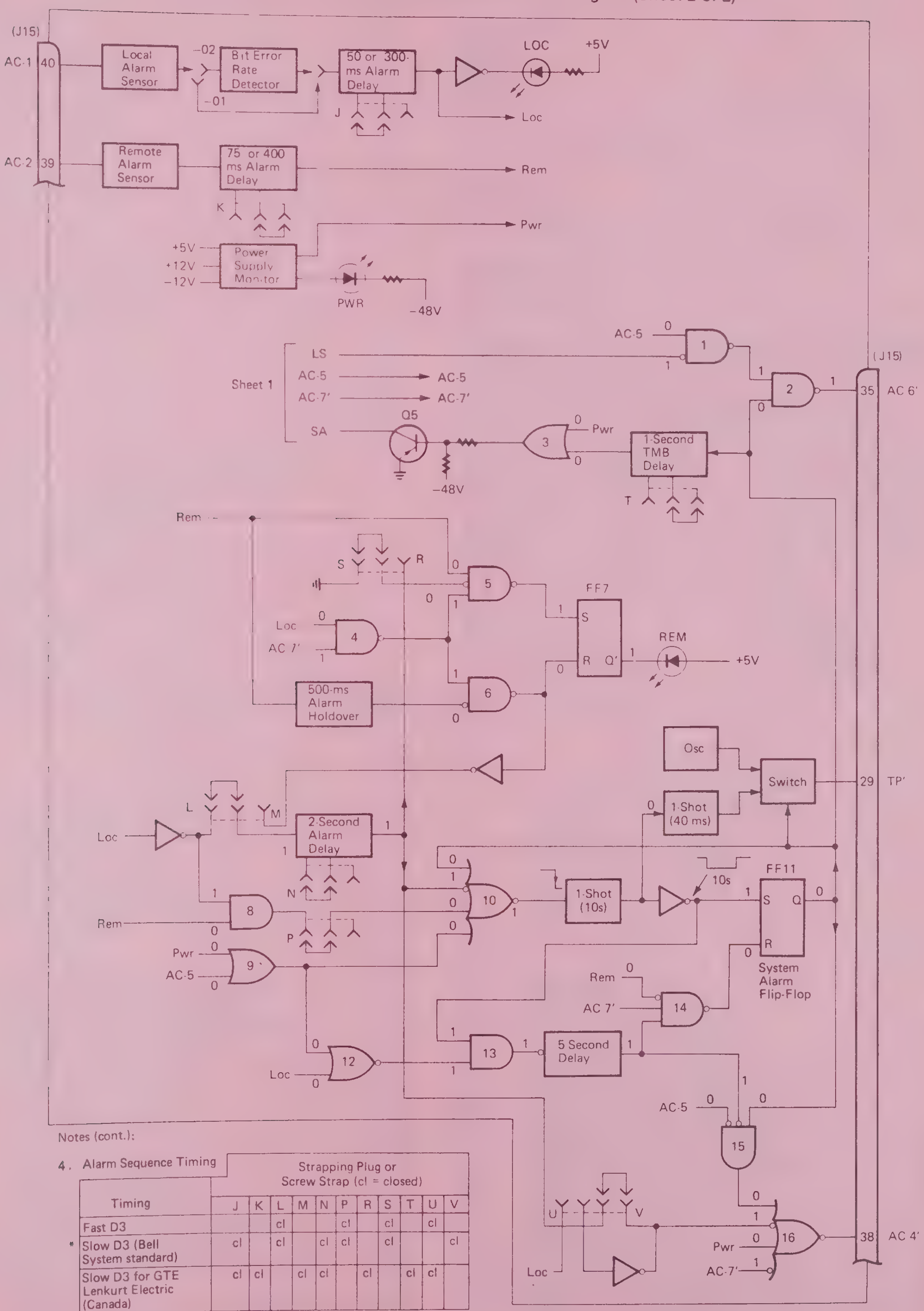

Screw-Strap
Strapping Plug
Closed
J
J
Open
J
J

Figure 3-8. 91230 Alarm and Control Unit Circuit Diagram (Sheet 2 of 2)


(J15)
AC-1
40
Local Alarm Sensor
-02
-01
Bit Error Rate Detector
50 or 300-ms Alarm Delay
J
LOC
+5V
Loc
AC-2
39
Remote Alarm Sensor
75 or 400 ms Alarm Delay
K
Rem
Pwr
+5V
+12V
-12V
Power Supply Monitor
PWR
-48V
AC-5
0
1
LS
1
(J15)
Sheet 1
AC-5
AC-5
AC-7'
AC-7'
2
35
AC 6'
Q5
SA
3
Pwr
1-Second TMB Delay
T
-48V
Rem
S
R
5
FF7
Loc
4
AC 7'
S
R
Q'
REM
+5V
500-ms Alarm Holdover
6
Osc
Switch
29
TP'
1-Shot (40 ms)
L
M
Loc
2-Second Alarm Delay
N
10
1-Shot (10s)
10s
FF11
S
Q
R
System Alarm Flip-Flop
8
Rem
P
Pwr
9
AC-5
Rem
AC 7'
14
12
Loc
13
5 Second Delay
AC-5
15
U
V
Loc
16
Pwr
AC-7'
38
AC 4'

Notes (cont.):

4. Alarm Sequence Timing

Timing	Strapping Plug or Screw Strap (cl = closed)										
	J	K	L	M	N	P	R	S	T	U	V
Fast D3			cl			cl		cl		cl	
* Slow D3 (Bell System standard)	cl		cl		cl	cl		cl			cl
Slow D3 for GTE Lenkurt Electric (Canada)	cl	cl		cl	cl		cl		cl	cl	

*Factory strapping

5. Logic States. Logic states (1 or 0) are shown for normal operating conditions.

TECHNICAL SUMMARY (Continued)

Timing	
Clock frequency	1.544 MHz
Channel sampling rate	8000 Hz
Bit time slot	648 ns
Channel pcm word (8 bits)	5.18 µs
Frame (193 bits)	125 µs
Input Power	
Voltage	44 to 56 Vdc (48 volts nominal)
Current	
Common equipment	0.8 ampere
Channel units	See figure 4-1
Test set	400 mA (when connected to 91230 alarm unit)
Environment	
Ambient temperature range	0 to 50°C (32 to 122°F)
Maximum relative humidity	95% at 40°C (104°F)
Maximum operating altitude	4572 m (15,000 feet)
Physical Arrangement	
Rack mounting	Standard 483-mm (19") rack; 356 mm (14") overall depth with 127 mm (5") forward projection from rack mounting surface
Mounting spaces	11 spaces, 489 mm (19-1/4")
Weight	45 kg (100 pounds) maximum, fully-equipped

Equipment	Weight kg	(pounds)	Dimensions, h x w x d Millimetres	(Inches)
91221 Transmit Common Equipment Unit	0.9	(2)	57 x 284 x 294	(2-1/4 x 11-3/16 x 11-9/16)
91222 Receive Common Equipment Unit	0.8	(1.8)	57 x 284 x 294	(2-1/4 x 11-3/16 x 11-9/16)
91230 Alarm and Control Unit	1	(2.3)	41 x 289 x 302	(1-5/8 x 11-3/8 x 11-7/8)
91232 Test and Alignment Set	6.4	(14)		2 rack mtg spaces
91235 Power Supply Unit	2.6	(5.7)	175 x 140 x 311	(6-7/8 x 5-1/2 x 12-1/4)
91220 Terminal Equipment Shelf See add	11.3	(25)		11 rack mtg spaces
Channels Units		See GTEP Section 342-911-108		
5215B Miniature Jackfield Assembly	2.3	(5)		1 rack mtg space
46820 Power Filter and Fuse Panel	10	(22)		2 rack mtg spaces
56620 Writing Shelf	2.5	(5.5)		1 rack mtg space
91065 Counter Panel	1.5	(3.3) fully equipped		1 rack mtg space
91155 Fuse and Alarm Shelf	3.6	(8) fully equipped		2 rack mtg spaces

GTE Lenkurt may change performance specifications where necessary to meet industry requirements.

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CD = Circuit Diagram

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1. GENERAL

1.01 This Section describes the 9002B PCM Channel Bank and includes specifications, functional operation, engineering considerations, ordering information, and installation procedures. Associated publications are listed in figures 1-1 and 1-2. For information on channel units, refer to Section 342-911-104 (910A system), Section 342-911-108, and the Sections listed in figure 1-2. Channel bank alignment, testing, and troubleshooting are covered in Section 342-911-109.

1.02 The equipment covered in this Section is the latest model as of the publication date. Later models are capable of greater application or are more effective in performance of their function than earlier models. A later model supersedes an earlier model of the same type number and may always be substituted for the earlier model.

Figure 1-1. Associated Publications

GTE Practices Section	Title
342-910-103	9101C PCM Repeatered Line Equipment
342-910-120 16x	9102A 48-Channel Repeatered Line Equipment
342-911-104	910A PCM Subscriber Carrier System
342-911-108	9002A/B PCM Channel Units
342-911-109	9002A/B PCM Channel Bank, Alignment and Testing
342-911-110	Type 9002A and 9002B PCM Channel Bank Equipment Compatibility
342-911-122	9122A Asynchronous Digital Multiplexer

Figure 1-2. Channel Unit Publications

Channel Unit	GTE Practices Section 342-911
91234 Four-Wire SF	-140
91237 Two-Wire Duplex	-141
91238 No. 2 EAX	-142
91240 Four-Wire E&M	-143
91241 Two-Wire E&M	-144
91242 Four-Wire	-145
91243 Dial Pulse Originating (DPO)	-146
91245 Dial Pulse Terminating (DPT)	-147
91250 Stop Dial/Wink Originating	-148
91251 ETS-4	-149
91252 Two-Wire E&M	-150
91253 Dial Pulse Originating (DPO)	-151
91254 Four-Wire E&M	-152
91255 Dial Pulse Terminating (DPT)	-153
91257 Four-Wire Tandem	-154
91258 Foreign Exchange Office	-155
91259 Foreign Exchange Subscriber	-155
91290 DPO/Incoming Trunk	-156
91291 DPT/Outgoing Trunk	-156

1.03 This Section is reissued to incorporate Issue 2 of Addendum 342-911-107, which provided information about the 91232-03 and -04 Test and Alignment Sets, the 91065 Counter Panel, and the 91330-04 Terminal Equipment Shelf. This issue also revises the Technical Summary, adds a 91300-25 rack assembly to figure 6-1, and describes a change from screw-straps to strapping plugs on the 91230 Alarm and Control Unit. Due to the extensive changes involved, marginal arrows are omitted.

1.04 Remove Issue 2 of this Section and Issue 2 of Addendum 342-911-107 from the binder or microfiche file and replace them with this issue.

2. DESCRIPTION

PCM Carrier System

2.01 A simple pulse code modulation (pcm) carrier system consists of two channel banks linked by a span line as shown in figure 2-1. The span line transmission facility uses one cable pair for each direction of transmission and has repeaters (pulse regenerators) at nominal spacing of 32 dB at 772 kHz. Channel banks may also be interconnected via digital multiplexers and higher-speed pulse transmission facilities.

2.02 The channel bank periodically samples the vf and signaling/supervisory inputs from up to 24 channels, converts the analog voltage values into binary digits, and combines these bits into a time-division multiplex signal at 1.544 Mb/s. At the far end, the channel bank converts the digital signal back to analog signals on the 24 channels.

2.03 The bipolar 1.544-Mb/s line signal of the channel bank is designated DS1, meaning "digital signal at the first level." At the standard DS1 cross-connect point, designated DSX-1, the signal level is 3 volts base-to-peak.

Channel Bank

2.04 The 9002B channel bank is end-to-end compatible with the 9004A and 9002A channel banks and with the Western Electric D4, D3, D2, and D1D channel banks. The following functions on the GTE Lenkurt channel bank have identical counterparts on the Western Electric channel banks: channel drop interface, including optional service restoral jacks and attenuators; signal sampling and encoding in the common equipment; DS1 signal format; span line interface, including equalizers; and alarm indications.

2.05 The D3, D2, and D1D channel banks differ in the sequence in which channels are sampled. The relationship between channel time slot in the DS1 signal and channel number is shown in figure 2-2; for example, time slot 1 contains information bits for channel 1 (D1D), channel 12 (D2), or channel 1 (D3). The 9002B channel bank is wired for the D3 sequence; a plug-in adapter is used to obtain the D2 or D1D sequence.

2.06 A 9002B channel bank (figure 2-3) consists of a 91330 Terminal Equipment Shelf, four common equipment units, and up to 24 channel units. The shelf occupies 11 mounting spaces on a standard 483-mm (19-inch) rack. It is 356 mm (14 inches) deep and projects 127 mm (5 inches) forward from the rack mounting surface. When fully equipped, the channel bank weighs between 36 and 45 kg (80 and 100 pounds).

2.07 The 91330-02, -03, and -04 shelves are "connectorized." This means that vf and signaling/supervisory leads of the 24 channels are grouped according to function

Figure 2-1. PCM Cable Carrier System

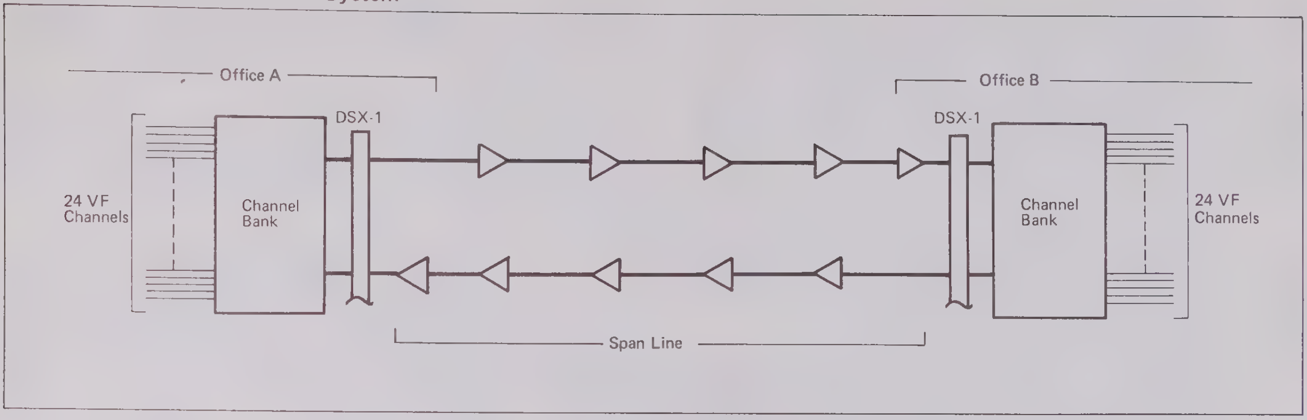
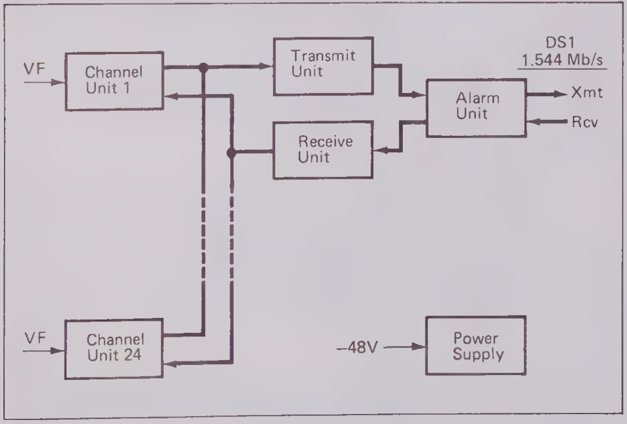


Figure 2-2. Channel Sampling Sequence

DS1 Time Slot	Channel Number		
	D3 Sequence	D2 Sequence	D1D Sequence
1	1	12	1
2	2	13	13
3	3	1	2
4	4	17	14
5	5	5	3
6	6	21	15
7	7	9	4
8	8	15	16
9	9	3	5
10	10	19	17
11	11	7	6
12	12	23	18
13	13	11	7
14	14	14	19
15	15	2	8
16	16	18	20
17	17	6	9
18	18	22	21
19	19	10	10
20	20	16	22
21	21	4	11
22	22	20	23
23	23	8	12
24	24	24	24

Figure 2-3. 9002B PCM Channel Bank



and wired to 50-pin connectors for hookup to office equipment via plug-in cable assemblies.

2.08 Standard factory-wired rack assemblies containing three to six connectorized channel banks are available. See Part 6 for complete description.

2.09 PCM Signal Format. During one frame, in sequence, the signal voltage on each channel is sampled and the sample amplitude is encoded as an eight-bit word. This process is repeated 8,000 times per second, making the length of one frame 125 μs.

2.10 The eight-bit channel word enables binary encoding of 256 discrete values ($2^8 = 256$). Accordingly, sample voltages are compared against a 256-step voltage curve. This process is known as quantizing and is equivalent in mathematics to rounding off to the nearest whole number. To maintain uniformly low distortion over a wide range of talker volumes, the curve has a compression characteristic with small steps at low levels and larger steps at higher levels.

2.11 In each frame, there are 192 channel bits (24 eight-bit channel words) plus an added S-bit ("shared" bit). The pattern of S-bits (1 or 0) over a 12-frame interval is detected at the receive terminal and used to control terminal framing and signaling frame identification.

2.12 The sampling rate of 8,000 multiplied by 193 gives the 1.544-Mb/s rate of the DS1 signal. At this rate, the time slot for a single bit is 648 ns and the length of an eight-bit channel word is 5.18 μs.

2.13 In alternate sixth frames, the least significant bit of the voice encoded signal (bit 8) on each channel is replaced by an A or B signaling bit. On some channel units, both bits represent the same condition; on others, the A signaling bit carries on-hook/off-hook information and the B signaling bit represents another condition, such as silent/ringing.

2.14 Channel Units. The 9002B channel bank can be equipped with various types of channel units. Intertoll trunking, toll-connecting, and exchange channel units are described in Section 342-911-108 and the Sections listed in figure 1-2. Channel units for subscriber and paystation applications are covered in Section 342-911-104.

2.15 Channel units are designed for standard office test levels and include front-face accessible transmit and receive level adjustments, a busy switch, pin jacks for headset monitoring of channel idle/busy status, and optional normalled-through jacks for service restoral, testing, and vf alignment.

2.16 Alarms. The channel bank monitors the condition of the local and remote common equipment and the local power supply. In the event of an abnormal condition, a local, remote, or power alarm indicator lights. Each alarm condition also produces a system alarm that busies the channel units and causes trunk connections to be open-circuited and subscriber charges to be stopped. (Some types of E&M channel units are busied only after they return to idle.) Dry contacts on the system alarm relay are available for audible and visual office alarm circuits.

2.17 Alignment. System alignment, a one-person operation that can be performed in a few minutes, consists of setting the receive and transmit levels on each channel unit; there are no common equipment adjustments. Because levels are independent of the transmission facility, they are set with the channel bank in a loopback mode. Additional end-to-end tests may be made to verify system performance.

---

3. FUNCTIONAL OPERATION

3.01 Part 3 describes functional operation of the channel bank common equipment, the 91232 test set, and the —48V power distribution equipment used with the channel bank. Circuit diagrams are included.

NOTE: In the text and diagrams of this publication, a binary signal that is logic 0 in the activated state is identified by a prime symbol (') following the signal name. This symbol has the same meaning as the "bar" used in other publications; for example: TMB' and $\overline{\text{TMB}}$, CHP-( )T' and $\overline{\text{CHP-( )T}}$, or Sig En B' and $\overline{\text{Sig En B}}$ refer to the same signals.

Terminal Equipment Shelf

3.02 Signal and Control Circuits. Figure 3-1 shows the main signal paths and control circuits between units of the 91330 shelf. For continuity of circuits through the common equipment, refer to figure 3-4 (transmit unit), 3-7 (receive unit), and 3-8 (alarm unit).

3.03 The channel unit on figure 3-1 is representative of channels 1 through 24. All connections are multipled between J1 through J12 and J17 through J28. External connections from channel units to the office equipment are shown in figure 8-3. For circuits within the channel units, refer to the Sections listed in figure 1-2 or Section 342-911-104 (910A system).

3.04 Power Supply and Distribution. Figure 3-2 is the power distribution diagram for the 91330 shelf. Entering at terminal board TB1, power from the —48V office battery is converted by the 91235-02 Power Supply Unit to +5V, +12V, and —12V supplies. Other external power is brought in at TB1 when required by certain types of channel units: 20-Hz ringing voltage by foreign-exchange subscriber channel units; 2600 Hz by single-frequency signaling channel units; —260/310V by subscriber channel units in the 910A system; —130V and +130V by paystation channel units in the 910A system; ringback tone by 91238 No. 2 EAX Channel Units.

3.05 The channel unit on figure 3-2 is representative of channels 1 through 24. All power distribution circuits are multipled between J1 through J12 and J17 through J28 except the 20-Hz ringing voltage, which has separate A and B distribution circuits to J1-J12 and J17-J28, respectively.

3.06 Channel Pulse Distribution. Figure 3-3 shows distribution of 24 transmit channel pulses CHP-( )T' and 24 receive channel pulses CHP-( )R'. The channel pulse gates the applicable channel unit to the pulse amplitude modulation (pam) and signaling buses during an assigned time slot of about 3 μs. In the D3 configuration, P1 plugs directly into J29. For the D1D configuration, the channel sampling sequence is rearranged by inserting a 91333-01 Channel Pulse Adapter between P1 and J29. For the D2 configuration, the 91333-02 version of the adapter is used.

Transmit Unit (figure 3-4)

3.07 In the 91221 Transmit Common Equipment Unit, pulse signals on the transmit pam bus, representing the voice-frequency output of 24 channel units, are sampled sequentially. The amplitude of each sample is encoded into an eight-bit word in which logic 1's and 0's are represented by discrete voltage levels. Channel signaling and supervisory states on the TCS-A and TCS-B buses are also sampled sequentially. During every sixth frame, the eighth bit of the encoded voice signal of each channel is inhibited and the signaling bit (A or B) is inserted in its place. At the beginning of every frame, an S-bit is inserted. The combined pcm bit stream goes through a converter that inverts alternate "1" pulses to form a bipolar signal of 324-nanosecond pulses at an amplitude of 6 volts base-to-peak.

3.08 Transmit Clock. Channel bank transmit timing is controlled by a 1.544-MHz clock signal (CP-T) from one of three sources. In ordinary operation, screw-straps R, S, T, and U are open and the output of the internal 1.544-MHz crystal-controlled clock goes through gates 7 and 9 to CP-T.

3.09 In certain applications of the channel bank with the GTE Lenkurt 9121A Synchronous Digital Multiplexer, transmit timing is synchronized to an external 1.544-MHz clock. Screw-strap U is closed, disabling gate 7 and enabling gates 8 and 9. From shelf terminal board TB2, the incoming clock signal goes through pin 43 of the transmit unit and screw-strap R to CP-T.

3.10 In other channel bank applications with a 9121A multiplexer or digital switching machine, transmit timing is synchronized to the 1.544-MHz clock (CP-R) recovered from the incoming pcm signal in the receive unit. This sync mode is called "looped receive clock." Screw-strap T is closed, disabling gate 7 and enabling gates 8 and 9. From the receive unit, CP-R goes via shelf terminal board TB2, pin 43 of the transmit unit, and screw-strap R to CP-T. In a system alarm condition with AC-4' or AC-7' activated or a loop test condition with AC-5' activated, the output of gate 10 goes to logic 1, disabling gate 8 and enabling gate 7. The 1.544-MHz clock in the transmit unit then becomes the CP-T source until the alarm or test condition ends.

3.11 Digit Pulses. Clocked by CP-T, the digit pulse generator produces waveforms D1 through D8 that divide the channel time slots into eight bit-intervals. See figure 3-5. A delayed D7 waveform (D7-1/2) is also produced. Digit pulses are used only within the transmit unit; for simplification, the complete distribution is omitted on figure 3-4. Under control of the Fr En pulse, which occurs during CHP-24T' in the normal mode or CHP-12T' in the loopback mode, digit pulses are held high for one clock cycle after D8. This provides an extra bit time that is assigned to the framing bit (S-bit). A D9 pulse and a clock signal to the framing generator are also produced during this time slot.

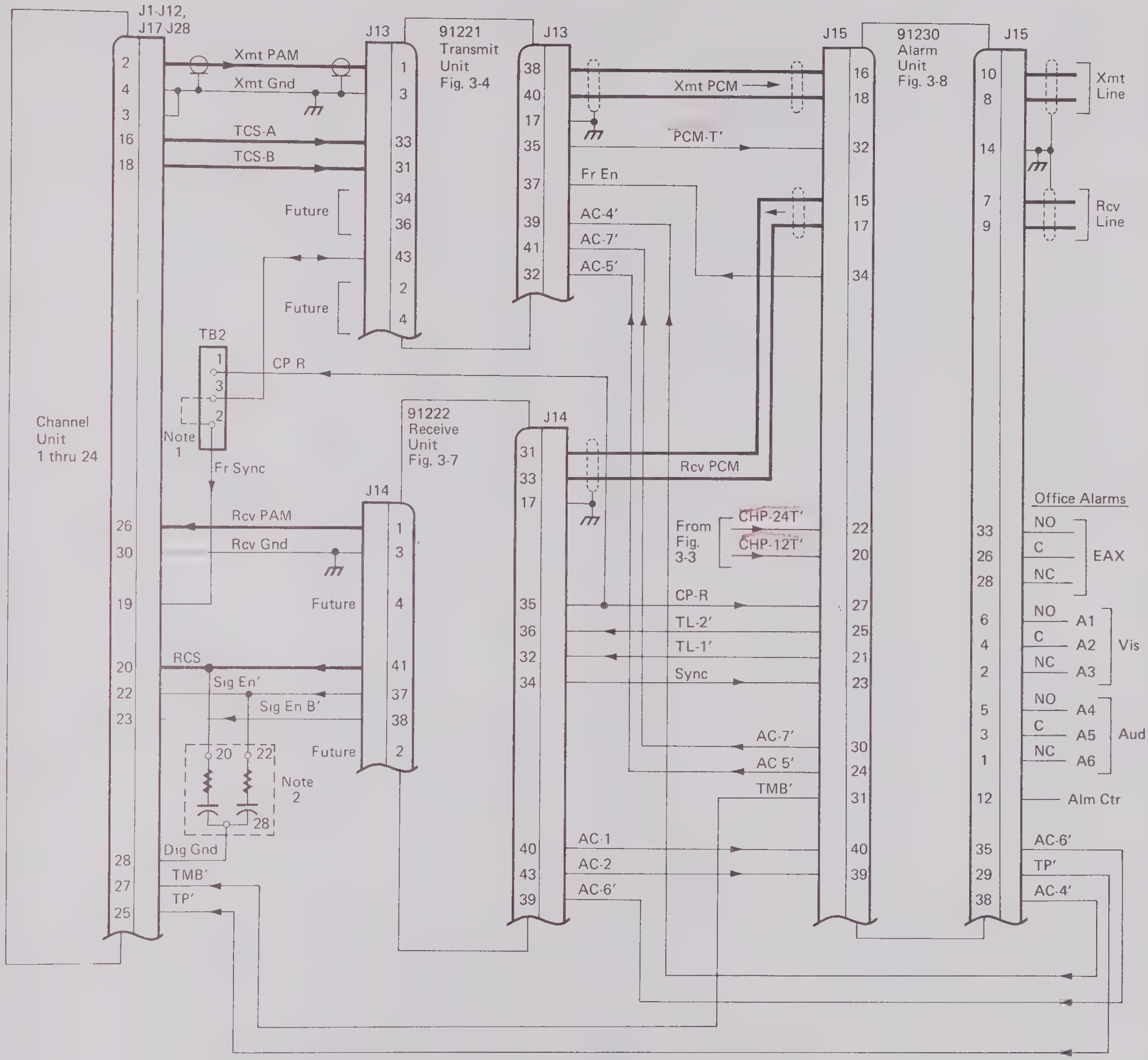
3.12 Channel Pulses. Digit pulse D4' drives the channel pulse generator, which produces CHP-1T' through CHP-24T' in a continuous sequence. As shown in figure 3-5, the normally high channel pulse goes low at D4 and returns high when the digit pulses go low at D8 or D9. For distribution of channel pulses to the channel units and to the alarm unit, see figure 3-3.

3.13 PAM Signal Sampling. Two sampling circuits selected alternately by successive channel pulses are used. While one circuit is sampling, the other is holding the sample of the preceding channel.

3.14 In the sampling circuit, the channel pulse turns on a transistor switch and a capacitor is charged to a voltage proportional to the pam signal amplitude. At the end of the channel pulse, the switch opens and the charge is held for encoding until D7-1/2 in the next channel time slot.

(Text continues on page 11.)

Figure 3-1. 91330 Shelf, Main Signal Diagram


J1-J12,
J17-J28
Channel Unit 1 thru 24
2
4
3
16
18
26
30
19
20
22
23
28
27
25
Xmt PAM
Xmt Gnd
TCS-A
TCS-B
J13
1
3
33
31
34
36
43
2
4
Future
Future
91221 Transmit Unit Fig. 3-4
J13
38
40
17
35
37
39
41
32
Xmt PCM
PCM-T'
Fr En
AC-4'
AC-7'
AC-5'
TB2
1
3
2
Note 1
CP R
Fr Sync
91222 Receive Unit Fig. 3-7
J14
Rcv PAM
Rcv Gnd
J14
1
3
4
41
37
38
2
Future
Future
RCS
Sig En'
Sig En B'
20
22
28
Note 2
Dig Gnd
TMB'
TP'
J14
31
33
17
35
36
32
34
40
43
39
Rcv PCM
From Fig. 3-3
CHP-24T'
CHP-12T'
CP-R
TL-2'
TL-1'
Sync
AC-7'
AC 5'
TMB'
AC-1
AC-2
AC-6'
J15
16
18
32
15
17
34
22
20
27
25
21
23
30
24
31
40
39
91230 Alarm Unit Fig. 3-8
J15
10
8
14
7
9
33
26
28
6
4
2
5
3
1
12
35
29
38
Xmt Line
Rcv Line
Office Alarms
NO
C
NC
EAX
NO
C
NC
A1
A2
A3
Vis
NO
C
NC
A4
A5
A6
Aud
Alm Ctr
AC-6'
TP'
AC-4'

NOTES:

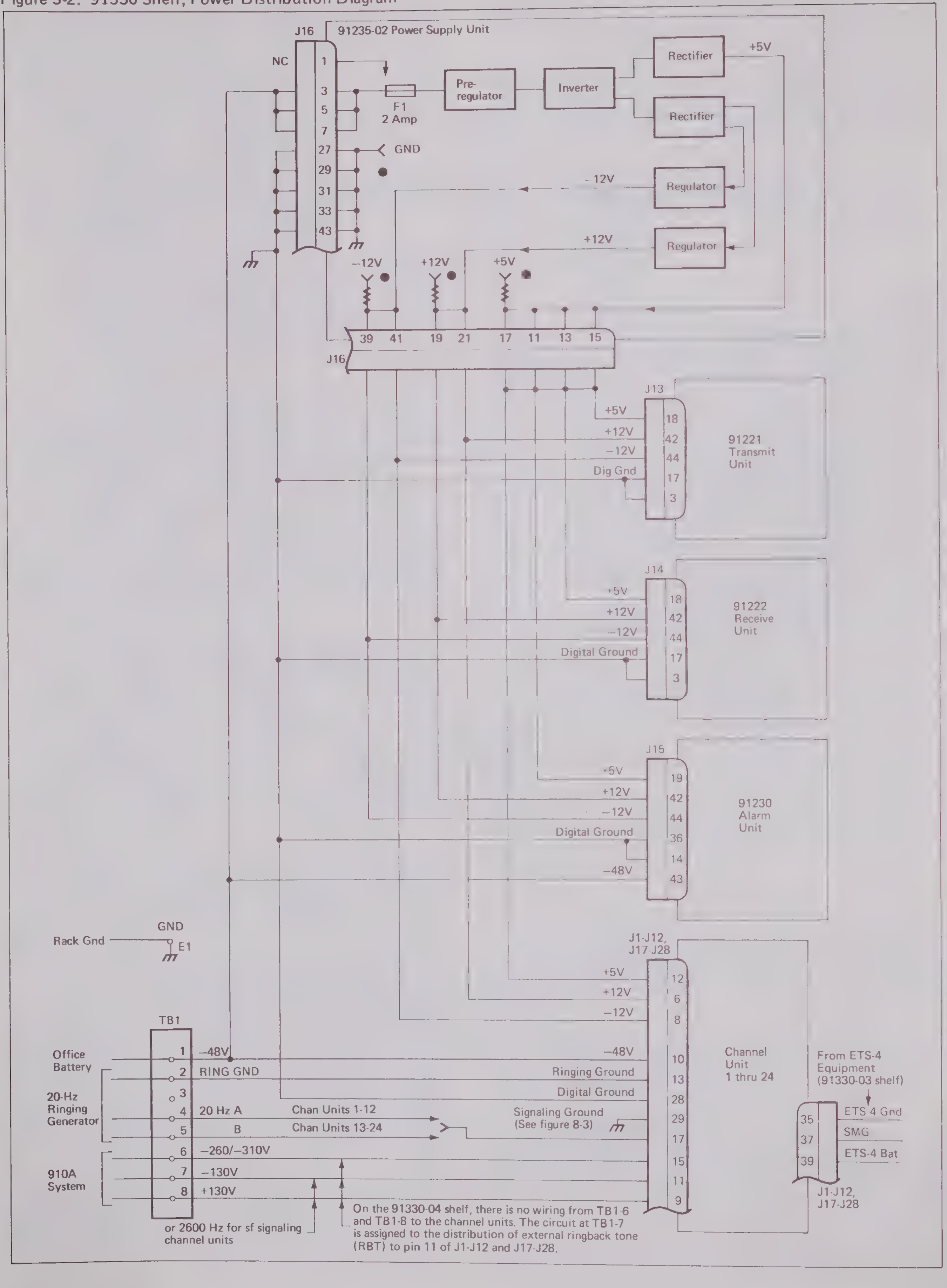
1. Strapping

Option		Strap TB2
Transmit clock source	Internal clock	2 to 3 *
	Looped receive clock	1 to 3
	External clock	No straps
Fr Sync pulse distribution to 910A channel units (used only with internal clock option)		2 to 3 *

*Factory strapping

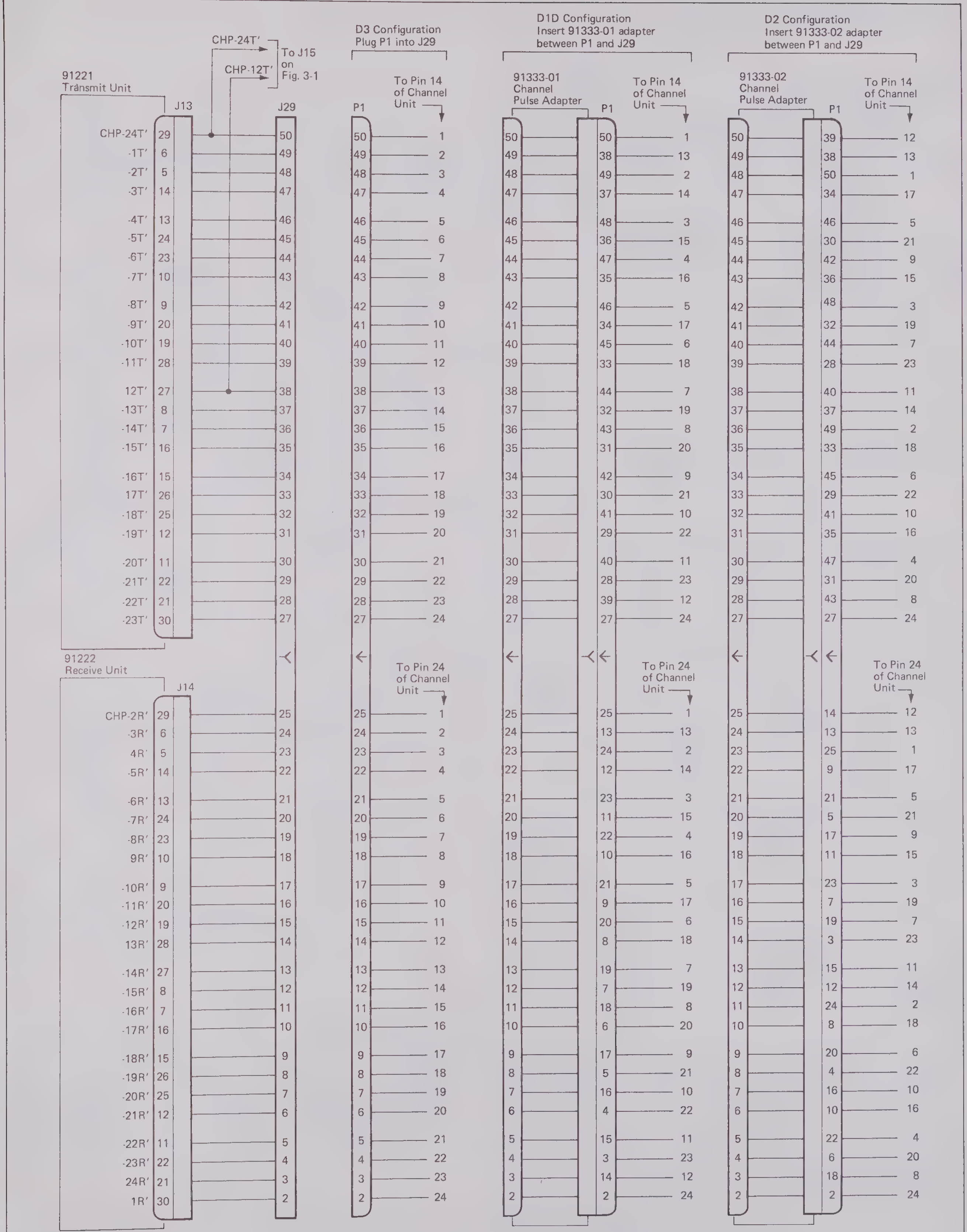
2. Suppression Network. To prevent negative-going spikes from entering the receive signal gates in the channel units, four 087-55496-01 Suppression Networks are connected to the RCS and Sig En' buses at J2, J12, J18, and J24.

Figure 3-2. 91330 Shelf, Power Distribution Diagram


J16
91235-02 Power Supply Unit
NC
1
3
5
7
27
29
31
33
43
F1
2 Amp
GND
Pre-regulator
Inverter
Rectifier
Rectifier
+5V
Regulator
Regulator
–12V
+12V
–12V
+12V
+5V
39
41
19
21
17
11
13
15
J16
J13
+5V
+12V
–12V
Dig Gnd
18
42
44
17
3
91221 Transmit Unit
J14
+5V
+12V
–12V
Digital Ground
18
42
44
17
3
91222 Receive Unit
J15
+5V
+12V
–12V
Digital Ground
–48V
19
42
44
36
14
43
91230 Alarm Unit
Rack Gnd
GND
E1
J1-J12, J17-J28
+5V
+12V
–12V
–48V
Ringing Ground
Digital Ground
Signaling Ground (See figure 8-3)
12
6
8
10
13
28
29
17
15
11
9
Channel Unit 1 thru 24
TB1
Office Battery
20-Hz Ringing Generator
910A System
1
2
3
4
5
6
7
8
–48V
RING GND
20 Hz A
B
Chan Units 1-12
Chan Units 13-24
–260/–310V
–130V
+130V
or 2600 Hz for sf signaling channel units
From ETS-4 Equipment (91330-03 shelf)
35
37
39
ETS 4 Gnd
SMG
ETS-4 Bat
J1-J12, J17-J28

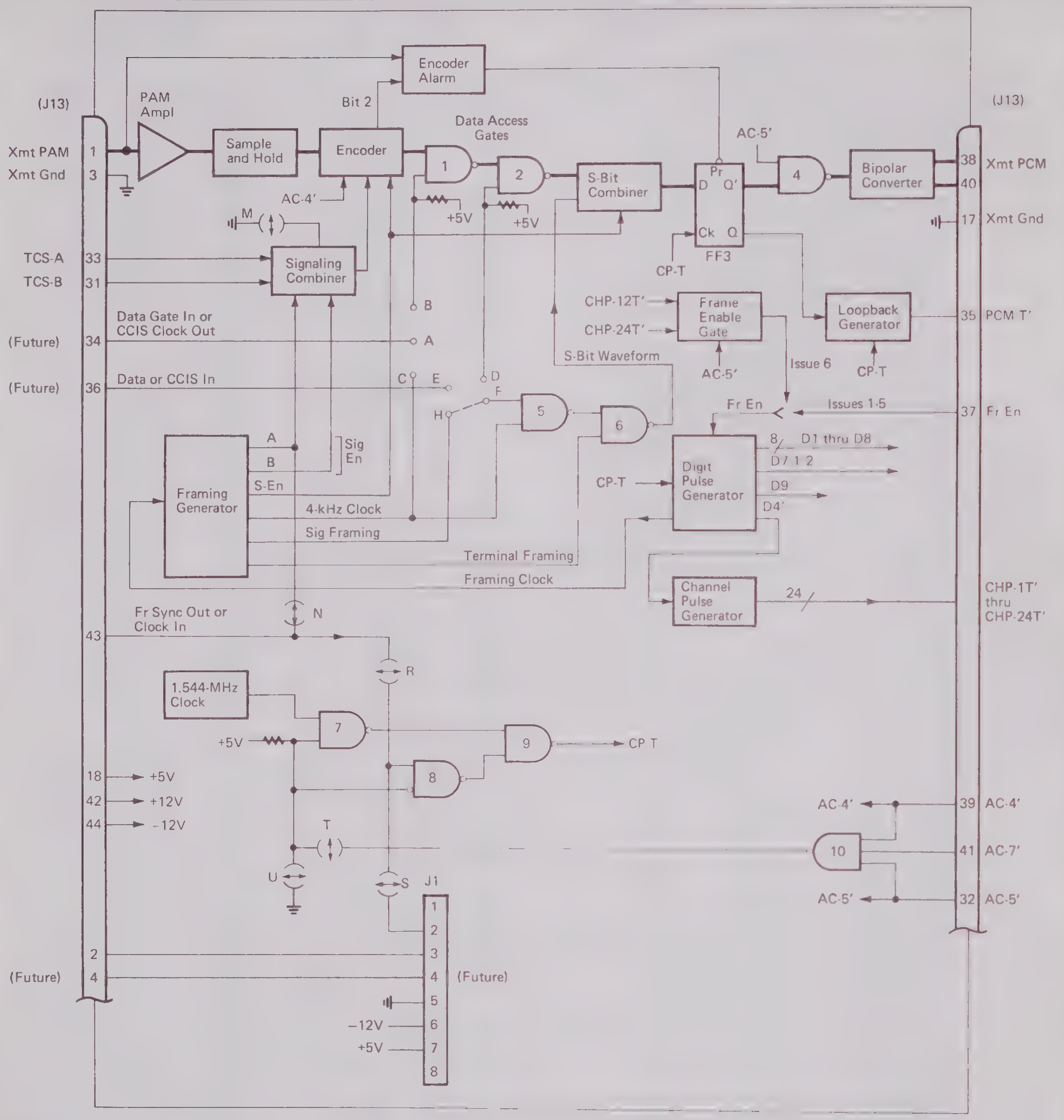
On the 91330-04 shelf, there is no wiring from TB1-6 and TB1-8 to the channel units. The circuit at TB1-7 is assigned to the distribution of external ringback tone (RBT) to pin 11 of J1-J12 and J17-J28.

Figure 3-3. 91330 Shelf, Channel Pulse Distribution Diagram


91221
Transmit Unit
J13
J29
CHP-24T'
CHP-12T'
To J15 on Fig. 3-1
D3 Configuration
Plug P1 into J29
P1
To Pin 14 of Channel Unit
D1D Configuration
Insert 91333-01 adapter between P1 and J29
91333-01 Channel Pulse Adapter
P1
To Pin 14 of Channel Unit
D2 Configuration
Insert 91333-02 adapter between P1 and J29
91333-02 Channel Pulse Adapter
P1
To Pin 14 of Channel Unit
CHP-24T' 29 50 50 1 50 50 1 50 39 12
-1T' 6 49 49 2 49 38 13 49 38 13
-2T' 5 48 48 3 48 49 2 48 50 1
-3T' 14 47 47 4 47 37 14 47 34 17
-4T' 13 46 46 5 46 48 3 46 46 5
-5T' 24 45 45 6 45 36 15 45 30 21
-6T' 23 44 44 7 44 47 4 44 42 9
-7T' 10 43 43 8 43 35 16 43 36 15
-8T' 9 42 42 9 42 46 5 42 48 3
-9T' 20 41 41 10 41 34 17 41 32 19
-10T' 19 40 40 11 40 45 6 40 44 7
-11T' 28 39 39 12 39 33 18 39 28 23
12T' 27 38 38 13 38 44 7 38 40 11
-13T' 8 37 37 14 37 32 19 37 37 14
-14T' 7 36 36 15 36 43 8 36 49 2
-15T' 16 35 35 16 35 31 20 35 33 18
-16T' 15 34 34 17 34 42 9 34 45 6
17T' 26 33 33 18 33 30 21 33 29 22
-18T' 25 32 32 19 32 41 10 32 41 10
-19T' 12 31 31 20 31 29 22 31 35 16
-20T' 11 30 30 21 30 40 11 30 47 4
-21T' 22 29 29 22 29 28 23 29 31 20
-22T' 21 28 28 23 28 39 12 28 43 8
-23T' 30 27 27 24 27 27 24 27 27 24
91222
Receive Unit
J14
To Pin 24 of Channel Unit
To Pin 24 of Channel Unit
To Pin 24 of Channel Unit
CHP-2R' 29 25 25 1 25 25 1 25 14 12
-3R' 6 24 24 2 24 13 13 24 13 13
4R' 5 23 23 3 23 24 2 23 25 1
-5R' 14 22 22 4 22 12 14 22 9 17
-6R' 13 21 21 5 21 23 3 21 21 5
-7R' 24 20 20 6 20 11 15 20 5 21
-8R' 23 19 19 7 19 22 4 19 17 9
9R' 10 18 18 8 18 10 16 18 11 15
-10R' 9 17 17 9 17 21 5 17 23 3
-11R' 20 16 16 10 16 9 17 16 7 19
-12R' 19 15 15 11 15 20 6 15 19 7
13R' 28 14 14 12 14 8 18 14 3 23
-14R' 27 13 13 13 13 19 7 13 15 11
-15R' 8 12 12 14 12 7 19 12 12 14
-16R' 7 11 11 15 11 18 8 11 24 2
-17R' 16 10 10 16 10 6 20 10 8 18
-18R' 15 9 9 17 9 17 9 9 20 6
-19R' 26 8 8 18 8 5 21 8 4 22
-20R' 25 7 7 19 7 16 10 7 16 10
-21R' 12 6 6 20 6 4 22 6 10 16
-22R' 11 5 5 21 5 15 11 5 22 4
-23R' 22 4 4 22 4 3 23 4 6 20
24R' 21 3 3 23 3 14 12 3 18 8
1R' 30 2 2 24 2 2 24 2 2 24

NOTE: On the 91330-04 shelf, channel pulse distribution circuits are wired from J13 and J14 directly to pins 14 and 24 of the channel units (at J1-J12 and J17-J28) as shown for the D3 configuration. Receptacle connector J29 and mating plug connector P1 are omitted.

Figure 3-4. Transmit Unit Circuit Diagram


(J13)
Xmt PAM
Xmt Gnd
1
3
PAM Ampl
Sample and Hold
Encoder
Encoder Alarm
Bit 2
Data Access Gates
1
2
S-Bit Combiner
Pr
D
Q'
Ck
Q
FF3
AC-5'
4
Bipolar Converter
(J13)
38
40
Xmt PCM
17
Xmt Gnd
AC-4'
M
+5V
+5V
TCS-A
TCS-B
33
31
Signaling Combiner
B
CP-T
CHP-12T'
CHP-24T'
Frame Enable Gate
AC-5'
Loopback Generator
CP-T
35
PCM T'
Data Gate In or CCIS Clock Out
(Future)
34
A
S-Bit Waveform
Issue 6
(Future)
36
Data or CCIS In
C
E
D
F
H
5
6
Fr En
Issues 1-5
37
Fr En
A
B
S-En
Sig En
Framing Generator
4-kHz Clock
Sig Framing
Terminal Framing
Framing Clock
CP-T
Digit Pulse Generator
8
D1 thru D8
D7 1 2
D9
D4'
Channel Pulse Generator
24
CHP-1T' thru CHP-24T'
Fr Sync Out or Clock In
N
43
R
1.544-MHz Clock
7
+5V
9
CP T
8
18
+5V
42
+12V
44
-12V
T
U
S
J1
AC-4'
39
AC-4'
10
41
AC-7'
AC-5'
32
AC-5'
2
(Future)
4
1
2
3
4
5
6
7
8
(Future)
−12V
+5V

NOTES:

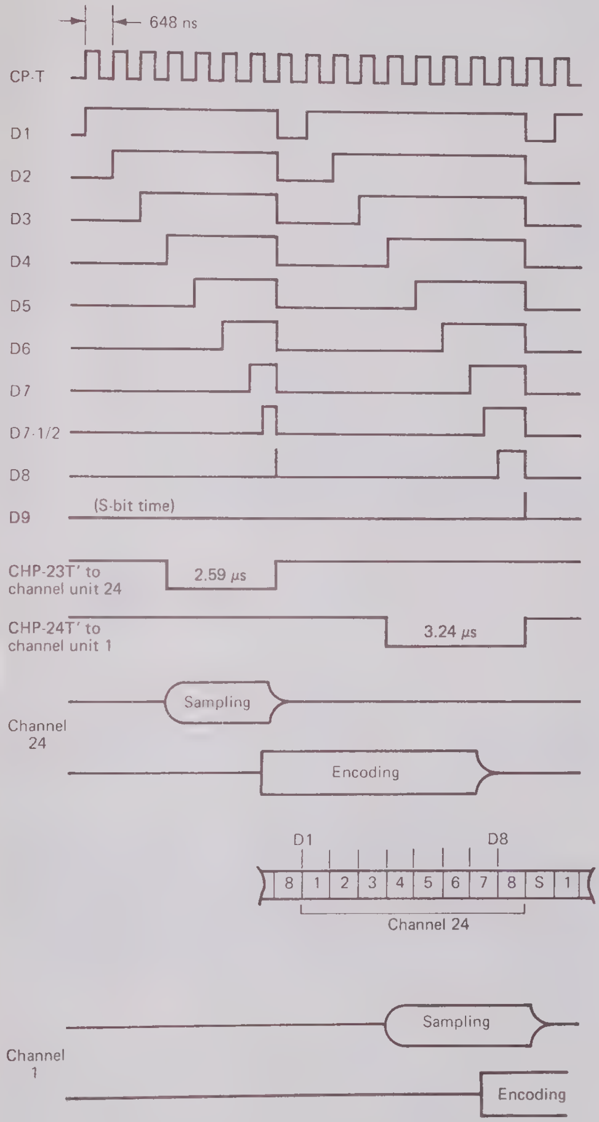
1. Screw-Strap Options

Option		Screw-Straps	
		Closed	Open
Transmit clock source	Internal clock		R, S, T, U *
	Looped receive clock	R, T	N, S, U
	External clock	R, U	N, S, T
Fr Sync pulse distribution to 910A channel units (used only with internal clock option)		N	R
Signaling	Normal (shared bit 8)		M *
	No signaling (eight-bit encoding)	M	

*Factory strapping

2. Wire-Strap Options. Strap only F to H. Terminals A through E are for future applications.

Figure 3-5. Transmit Unit Timing Diagram



NOTES:

1. In the D3 channel sampling sequence shown, channels 1 thru 24 are sampled by CHP-24T' and CHP-1T' thru CHP-23T', respectively.

(Continued from page 6.)

3.15 Encoder. Figure 3-6 shows a curve representing quantization of pam sample voltages according to the D3 format. This segmented curve approximates a continuous compression law (μ-law) curve defined as:

$$y = \frac{\ln(1+\mu x)}{\ln(1+\mu)}$$

where x and y respectively are the encoder input and output and $\mu = 255$.

3.16 The curve has eight positive segments and eight negative segments with 16 steps in each segment, a total of 256 quantizing steps. Within each segment, the steps are uniform; in adjacent segments, according to the compression law, step sizes are in a 2/1 ratio with the smallest steps at the lowest signal levels.

3.17 In the encoder, the sample voltage is compared with a reference voltage that is adjusted under logic control by the successive approximation method. In this method, the reference voltage is set at the halfway point on that portion of the curve where, based on results of preceding comparisons, the sample voltage is known to lie. Dual comparators are used for alternate channels.

3.18 In the first comparison, the polarity of the sample is determined and encoded as bit 1 of the eight-bit pcm word; positive is logic 1 and negative is logic 0. Succeeding comparisons localize the sample voltage to one segment of the curve and encode the segment number as bits 2, 3, and 4. Then, the applicable step in that segment is found and the number encoded as bits 5, 6, 7, and 8. The lowest numbered bit is the most significant bit.

3.19 Continuous operation of clock recovery circuits in the line repeater units and at the receive channel bank depend on the pcm signal containing an average of one "1" pulse in every eight-bit word with a maximum of 15 consecutive 0's. In the instance where the sampled signal level causes all eight bits of a pcm word to be coded logic 0, bit 7 of that word is forced to logic 1 before it is transmitted.

3.20 Encoder Alarm. In the encoder alarm circuit, the pam signal amplitude is compared with a fixed dc reference voltage. If the amplitude corresponds to a level greater than —21 dBm0, the comparator puts out a logic 1. For such an amplitude, bit 2 of the encoded channel word also should be logic 1. If it is not, an error pulse is generated. Several error pulses in succession cause the encoder alarm output to latch in a logic 0 state until normal encoding resumes. This logic 0 output presets flip-flop 3, forcing an all-1's pcm signal on the transmit line, which results in a local alarm at the remote terminal. As an acknowledgment, the remote terminal suppresses bit 2 of its transmit signal to produce a remote alarm at the local terminal.

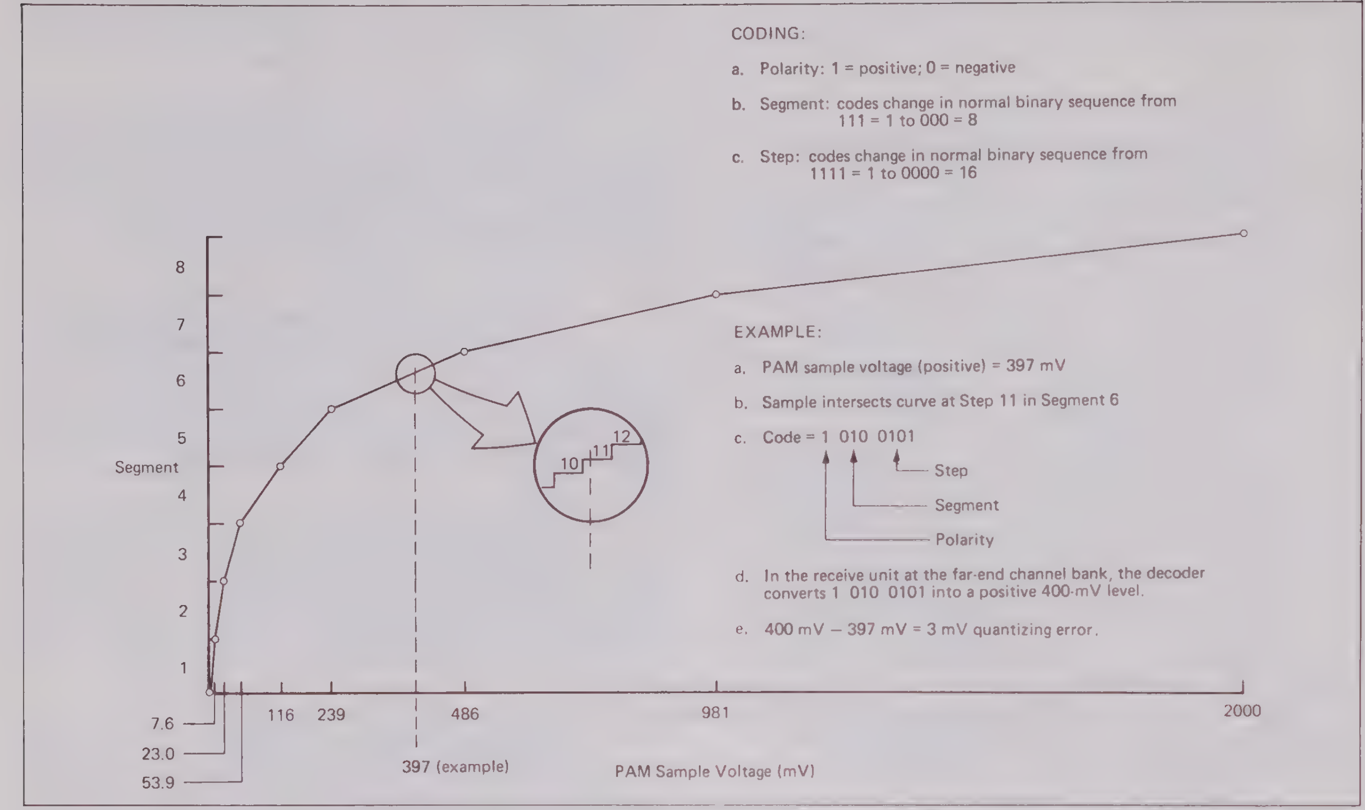
3.21 Data Access Gates. In normal operation, strap-points B and D are open, enabling gates 1 and 2. For future applications, these gates provide a means for inserting a 64-kb/s data channel in place of one vf channel. The bit rate of the data channel equals the product of the channel sampling rate (8,000 times per second) and the pcm word length (8 bits).

3.22 For channel bank operation with a data channel, A-B and D-E are strapped. During the data channel time slot, a logic 0 on the Data Gate input at pin 34 blocks the bit stream at gate 1. The output of gate 1 goes to logic 1, enabling gate 2. Meanwhile, eight bits from the data channel unit enter at pin 36 and join the bit stream at gate 2.

3.23 CCIS System. In future applications with a common channel interoffice signaling (CCIS) system, a 4-kb/s data channel containing signaling information for the 24 voice channels enters the transmit unit at pin 36. Through strap E-F and gate 5, the data is inserted in the pcm bit stream in place of the signaling framing S-bits. Signaling from individual channel units on TCS-A and TCS-B is not used and strap M is closed to permit full eight-bit encoding of the voice signals. A 4-kHz clock is supplied through strap A-C and pin 34 to the CCIS equipment.

3.24 Framing and Signaling. At the beginning of each 24-channel frame, the digit pulse generator interrupts channel pulse generation for one clock cycle to create

Figure 3-6. Quantization of PAM Sample Voltage



CODING:

a. Polarity: 1 = positive; 0 = negative

b. Segment: codes change in normal binary sequence from
111 = 1 to 000 = 8

c. Step: codes change in normal binary sequence from
1111 = 1 to 0000 = 16

EXAMPLE:

a. PAM sample voltage (positive) = 397 mV

b. Sample intersects curve at Step 11 in Segment 6

c. Code = 1 010 0101
Step
Segment
Polarity

d. In the receive unit at the far-end channel bank, the decoder converts 1 010 0101 into a positive 400-mV level.

e. 400 mV − 397 mV = 3 mV quantizing error.

an extra time slot. At the same time, the framing generator is supplied with a clock pulse from which various waveforms associated with the signaling combiner and S-bit combiner are derived.

3.25 S-bits (framing bits) are inserted in the extra time slots to synchronize receive timing at the distant channel bank with the incoming pcm signal. From the pattern of S-bits in a 12-frame sequence called a superframe, a terminal framing pattern identifies the location of time slot no. 1 in each frame and a signaling framing pattern identifies frames 6 and 12 in which signaling channels A and B are transmitted. Terminal framing has an alternating 1/0 S-bit pattern of 101010 in odd-numbered frames between 1 and 11. Signaling framing has an S-bit pattern of 001110 in even-numbered frames between 2 and 12; the signaling S-bit changes from 0 to 1 at frame 6 and from 1 to 0 at frame 12.

3.26 Signaling framing is clocked through gate 5 and interleaved with terminal framing in gate 6. The 648-nanosecond S-En pulses inhibit the encoder while strobing the S-bits into the pcm pulse stream.

3.27 In the signaling combiner, the Sig En A and B waveforms cause sampling of information on TCS-A and TCS-B at the D8 time of each channel during frames 6 and 12, respectively. The signaling information enters the encoder where it overrides the bit 8 vf information.

3.28 If signaling and supervision is not transmitted over the individual vf channels, screw-strap M is closed. This blocks the signaling path to the encoder and causes full eight-bit encoding of vf information.

3.29 The Sig En A waveform is utilized as a timing source by certain subscriber-type channel units in the 910A system. With pin 43 not used for a clock input, the waveform (designated Fr Sync) is distributed to pin 19 of all channel units. Screw-strap N is closed and R is open and terminals 2 and 3 on shelf terminal board TB2 are strapped.

3.30 Loop Test. The PCM-T' signal from the loopback generator is a unipolar version of the transmit pcm signal, but with 150-ns pulses instead of 324-ns pulses. In the loop test mode, PCM-T' goes through LT relay contacts on the alarm unit to the receive pcm signal path. Also, AC-5' goes to logic 0, holding the signal from gate 4 at a steady logic 1. This makes the bipolar converter output an all-1's transmit pcm signal, which produces a local alarm at the remote channel bank.

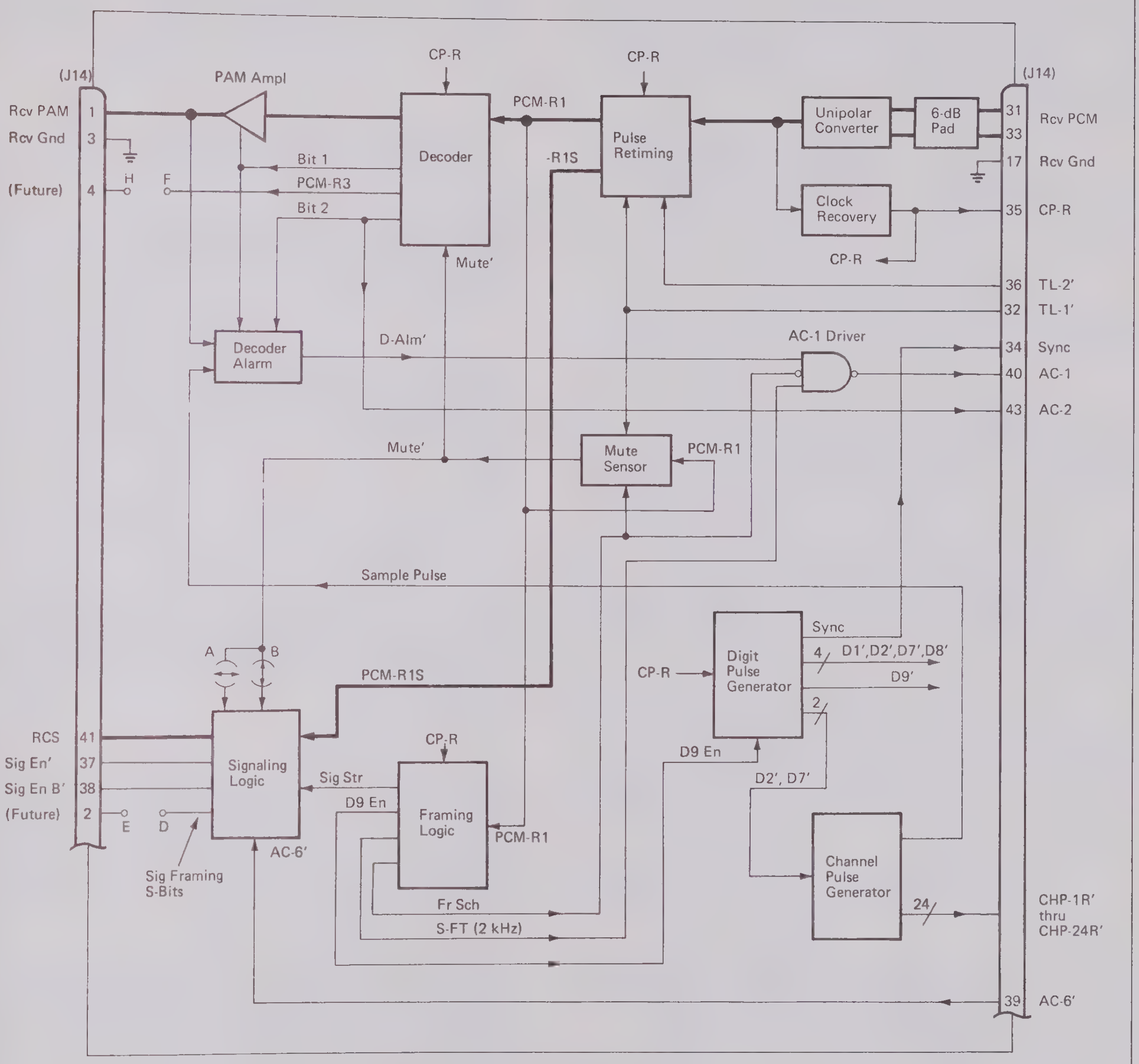
NOTE: Fr En is connected to CHP-24T' in the normal mode of operation and switched to CHP-12T' in the loop test mode. Prior to Issue 6 of 91221-M2, the switching was done on the alarm unit by contacts of the LT relay. At Issue 6, a frame enable gate was added to the transmit unit to do the switching under control of AC-5'. The purpose of this change was to prevent reframing caused by noise pickup on the interunit Fr En wiring.

Receive Unit (figure 3-7)

3.31 In the 91222 Receive Common Equipment Unit, the incoming bipolar pcm signal is converted to unipolar form and retimed by CP-R pulses from the clock recovery circuit. The pcm signal is then converted in the decoder to a time-division multiplex pam signal, which is amplified and routed via the receive pam bus to the 24 channel units. Each channel unit gates in a pulse at its assigned time slot every 125 μs and integrates these pulses in a lowpass filter to reproduce the analog voice signal of the channel.

3.32 Receive Clock. The clock recovery circuit uses a voltage-controlled oscillator and a phase-locked loop to generate a CP-R clock that is locked to the incoming bit stream and phased to sample the bits at their center points. CP-R is generated even in the absence of a

Figure 3-7. Receive Unit Circuit Diagram


(J14)
Rcv PAM
Rcv Gnd
(Future)
1
3
4
H
F
PAM Ampl
CP-R
Decoder
Bit 1
PCM-R3
Bit 2
Mute'
PCM-R1
-R1S
CP-R
Pulse Retiming
Unipolar Converter
6-dB Pad
Clock Recovery
CP-R
(J14)
31
33
17
35
36
32
34
40
43
Rcv PCM
Rcv Gnd
CP-R
TL-2'
TL-1'
Sync
AC-1
AC-2
Decoder Alarm
D-Alm'
AC-1 Driver
Mute'
Mute Sensor
PCM-R1
Sample Pulse
A
B
PCM-R1S
CP-R
Digit Pulse Generator
Sync
4
D1',D2',D7',D8'
D9'
2
D9 En
D2', D7'
RCS
Sig En'
Sig En B'
(Future)
41
37
38
2
E
D
Signaling Logic
Sig Str
D9 En
CP-R
Framing Logic
PCM-R1
AC-6'
Sig Framing S-Bits
Fr Sch
S-FT (2 kHz)
Channel Pulse Generator
24
CHP-1R' thru CHP-24R'
39
AC-6'

NOTES:

1. Screw-Strap Options.

Option		Screw-Straps	
		Closed	Open
Channel signaling state during frame search or remote alarm	*On-hook	A	B
	Off-hook	B	A

*The on-hook option is not recommended if the channel bank is equipped with FXS channel units because repeatered line disturbances will produce subscriber ringing. A disturbance that lasts more than about 140 milliseconds will cause trunk calls to be dropped also.

2. Wire-Strap Options. Terminals D, E, F, and H are for future applications. Do not strap.

line signal so that signaling states are held and out-of-frame indications are not upset by line faults.

3.33 Digit Pulses. Clocked by CP-R, the digit pulse generator produces waveforms D1' through D8' that divide the channel time slots into eight bit times. Under control of the D9 En pulse, a D9' pulse is generated at the beginning of each 24-channel sequence to provide a time slot for the S-bit. For simplification, digit pulse distribution is omitted on figure 3-7.

3.34 Another output of the digit pulse generator is the positive-going 324-ns Sync pulse, which occurs at D8 time during CHP-24R'. Sync pulses go through the 91230 alarm unit to the 91232 test set where they synchronize digital test signals with receive timing in the channel bank.

3.35 Channel Pulses. Digit pulses D2' and D7' drive the channel pulse generator, which produces CHP-1R' through CHP-24R' in a continuous sequence. In its assigned 5.18-μs time slot, the normally high channel pulse goes low at D2 time and returns high at D7.

3.36 Pulse Retiming. The pcm signal is retimed by CP-R to produce PCM-R1 and PCM-R1S; these are nrz (non-return-to-zero) signals corresponding to the incoming data with bits having 648 nanoseconds duration. PCM-R1S is an inversion of PCM-R1 except when TL-1' is activated.

3.37 Test signals TL-1' and TL-2' originate in the 91232 test set and are routed through the 91230 alarm unit. When the test set is conditioned to insert a digital test signal code in the bit stream, TL-1' goes to logic 0 while the code is present on TL-2'. The code is inserted in PCM-R1 but PCM-R1S is forced to logic 1 to produce an on-hook signaling condition in the applicable channel unit.

3.38 Mute Sensor. Bit 2 of each channel word in the receive signal is monitored by sampling PCM-R1 with the D2 pulse. When a remote alarm occurs, bit 2 becomes logic 0 and after 70 milliseconds the Mute' lead goes to logic 0. The same delayed activation of the Mute' lead takes place when the Fr Sch lead goes to logic 1 during reframing.

3.39 When the Mute' lead is activated, vf channels are muted by the decoder and signaling channels are forced on-hook or off-hook (screw-strap A or B) by the signaling logic.

3.40 When a digital signal representing 1 kHz on all channels is supplied by the 91232 test set on TL-2', all bit 2's are logic 0. Accordingly, operation of the mute sensor is inhibited by logic 0 on TL-1'.

3.41 Decoder. Bit 1 of each pcm word represents the signal voltage polarity of the pam signal to be reconstructed and bits 2 through 8 define signal amplitude. In the decoder, the incoming serial bits of each word enter an eight-bit shift register. At D8 time, the eight bits are loaded in parallel into a storage register. The parallel output of the storage register, through logic circuits, controls eight current switches and eight R/2R resistor summing networks that create a pam signal with amplitude corresponding to the binary code of the incoming pcm word. (The serial output of the shift register, PCM-R3, is available through strap H-F for future applications involving data equipment or program channel units.

3.42 PAM Amplifier. The steady state bias at the output of the pam amplifier is +2.6 volts. The maximum excursions of the pam pulses are to +4.6 volts or to +0.6 volt according to the logic state of polarity bit 1. The duration of the pulse for each channel is 5.18 μs.

3.43 Decoder Alarm. The decoder alarm circuit is enabled by a sample pulse that is logic 1 between D2 and D7 in each channel pulse time. If bits 1 and 2 of the receive signal are logic 1, corresponding to a signal level greater than −25 dBm0, and the pam signal amplitude is less than 117 millivolts, an error pulse is generated. If several such error pulses occur in succession, D-Alm' goes to logic 0 as an indication of decoder failure. Feedback in the alarm circuit locks D-Alm' in this state until the decoder starts to function properly.

3.44 Framing Logic. As described previously, the 101010 terminal framing pattern and the 001110 signaling framing pattern are interleaved in alternate frames over a 12-frame interval. In the framing logic circuit, PCM-R1 is sampled at the receive unit S-bit time every other frame, looking for the 101010 pattern. If two successive sample bits are the same, they can't be terminal framing S-bits and an error is tallied.

3.45 When the error density reaches approximately three errors in five samples, reframing is initiated. A D9 En pulse from the framing logic causes the digit pulse generator to add an extra digit to channel pulse CHP-1R'. This shifts the receive unit timing one bit with respect to the framing pattern of the incoming signal. The process is repeated, one bit per frame, until synchronization is achieved.

3.46 The Fr Sch lead goes high when reframing begins and remains high until 10 consecutive samples are made without error.

3.47 As part of the framing logic, there is a circuit to detect and correct a condition in which the polarity bit of a channel transmitting a frequency near 2 kHz is mistaken for the terminal framing bit. The polarity bit pattern in this case would be continuously 1100, which is 1/0 in every other frame, the same as the terminal framing bit pattern.

3.48 Signaling Logic. In the signaling logic circuit, PCM-R1S is sampled by the Sig Str waveform generated in the framing logic circuit. A Sig Str pulse occurs at S-bit time in each signaling frame. From the 001110 pattern of S-bits, the A and B signaling frames can be identified. The A frame is the first of the three consecutive signaling frames in which the S-bit is 1; the B frame is the first in which the S-bit is 0.

3.49 During signaling frames, bit 8 of each channel word is extracted from PCM-R1S and assembled into a time-multiplexed signal on the RCS bus. Sig En' and Sig En B' waveforms enable the channel units to gate RCS during signaling frames and discern between A and B frames. Sig En' goes low during A and B frames and Sig En B' goes low during B frames.

3.50 As mentioned before, signaling channels are forced on-hook or off-hook by a Mute' condition through screw-strap A or B, respectively. In a system alarm, when AC-6' goes to logic 0, signaling states are forced to on-hook, overriding the effect of the Mute' waveform.

3.51 The signaling framing S-bits are made available for future CCIS applications through strap D-E.

3.52 Local Alarm. In normal operation, the AC-1 driver is enabled by logic 1 on D-Alm' and logic 0 on Fr Sch. The S-FT signal derived from the terminal framing bits is a 2-kHz square wave, which becomes AC-1. If synchronization is lost, S-FT changes to a random signal with frequency less than 2 kHz. In the event of decoder failure or loss of receive signal or during frame search, the driver is disabled and AC-1 becomes logic 1.

3.53 Remote Alarm. The AC-2 signal from the decoder represents the status of bit 2 in PCM-R1. In normal operation, AC-2 consists of random 5.18-μs negative pulses, one for each channel word that has bit 2 at logic 1. During a local alarm at the distant channel bank, all bit 2's are transmitted as logic 0. In response, AC-2 at the local terminal goes to logic 1 to initiate a remote alarm indication on the 91230 alarm unit.

Alarm Unit (figure 3-8)

3.54 The 91230 Alarm and Control Unit monitors (1) output voltages of the power supply unit, (2) synchronization of the local receive unit with the remote transmit unit, and (3) status of bit 2 in the incoming pcm channel words. The unit also includes circuits for setting up various channel bank test modes and, at the ALIGN connector, an interface with the 91232 test set. Alarm conditions or test conditions are identified by lighted indicators on the alarm unit and by office alarms controlled by relays on the alarm unit.

3.55 As shown on sheet 1 of the circuit diagram, figure 3-8, transmit and receive DS1 signals pass through the alarm unit to the line. A 6-dB pad strapped into the transmit path reduces the line level to 3 volts base-to-peak. Depending on the length of cable to the next equipment, one of two cable equalizers may be inserted in the transmit path in place of the 6-dB pad.

3.56 Power Alarm. If the input fuse on the power supply unit blows or if any of the three dc output voltages fail, the power supply monitor (sheet 2 of figure 3-8) lights the red PWR indicator and changes the Pwr lead from logic 0 to logic 1. At gate 3, the change to logic 1 on Pwr turns off transistor Q5, releasing the SA (system alarm) relay. At gate 9, logic 1 on Pwr initiates a local alarm and, at gate 16, it changes AC-4' to logic 0, which inhibits bit 2 transmission to initiate a remote alarm at the distant terminal.

3.57 Local Alarm. Normally, a 2-kHz square wave from the receive unit is present on the AC-1 lead, indicating that the local receive unit is synchronized (in frame) with the distant transmit unit. A decoder alarm, an out-of-frame condition, or a loss of receive signal changes the 2-kHz square wave to a steady logic 1. After 50 ms (strap J closed) or 300 ms, the red LOC indicator lights and the Loc lead changes to logic 1. The effect of a change on the Loc lead is felt at gates 4, 8, 12, and 16 as described later.

3.58 Remote Alarm. Loss of bit 2 in the received channel word of all channels causes the AC-2 lead to become a steady logic 1. After 75 ms (strap K closed) or 400 ms, the Rem lead changes from logic 0 to logic 1. In either the fast or slow D3 alarm sequence (paragraph 3.76), with strap S closed and R open, flip-flop 7 is set by logic 1 on Rem through gates 5 and 6. To prevent response to a remote alarm that occurs after a local alarm, logic 1 on Loc makes the gate 4 output logic 0 to inhibit gate 5. However, gate 4 is itself inhibited under TMB hold conditions as described in paragraph 3.82.

3.59 In the optional slow D3 sequence for GTE Lenkurt Electric (Canada), with strap S open and R closed, the middle input of gate 5 is normally logic 1. (Also, strap M is closed, N is closed, and L is open.) Now, when Rem goes to logic 1, gate 5 stays inhibited until logic 1 at the output of gate 6 travels through the inverter, strap M, the 2-second alarm delay, and strap R to arrive as logic 0 at the middle input of gate 5. Thus, lighting of REM is delayed for 2 seconds.

3.60 When a remote alarm condition ends, Rem restores to logic 0. The S input of flip-flop 7 goes to logic 1 and, after 500 ms, the R input goes to logic 0, resetting flip-flop 7 and extinguishing the REM indicator.

3.61 The 500-ms alarm holdover has an important function in the following special situation. If flip-flop 7 is set and the far-end channel bank is placed in the loopback mode, the all-1's signal received at the near-end channel bank causes a local alarm and, because bit 2 changes from logic 0 to logic 1, Rem goes to a normal logic 0. However, while the 500-ms alarm holdover is timing out, the logic 1 on Loc inhibits gate 6 through gate 4 to prevent resetting of flip-flop 7. Without this delay, LOC would light and REM would go out. Instead, both indicators are lighted. Thus, important troubleshooting information is not lost at the near end because of a troubleshooting procedure at the far end.

3.62 System Alarm. A system alarm is initiated by a power, local, or remote alarm. With the ACO (alarm cutoff) relay operated, an existing system alarm will be maintained by the LT (loop test) relay operated or by slide-switch S3 in TMB HOLD position.

3.63 Gate 3 operates the SA (system alarm) relay through transistor Q5. A power alarm or flip-flop 11 in a set condition changes the gate 3 output to logic 1, turning off Q5 and releasing SA.

3.64 Release of the SA relay lights the yellow SYSTEM ALARM lamp and activates office alarms through two sets of form C contacts. Also available on the SA relay for external connections are one set of form C contacts to control alarm equipment in an electronic exchange and an open/ground contact to control an alarm counter.

3.65 With the SA relay released, momentarily pushing the ACO button operates the ACO relay and lights the ACO indicator. Contacts of the operated ACO relay restore the audible office alarm circuit (A4, A5, and A6) to normal and partially enable the channel bank loop test circuits.

3.66 System Alarm Flip-Flop. A local, remote, or power alarm or a loop test mode (AC-5 = 1) sets flip-flop 11, which then cannot be reset for at least 15 seconds. The Q output of flip-flop 11 going to logic 1 activates various alarm functions, principally the system alarm.

3.67 The following sequence takes place when an alarm condition changes the state of one of three inputs to gate 10, initiating operation of flip-flop 11.

(a) Gate 10 output goes to logic 0, triggering a 10-second one-shot.

(b) The S input of flip-flop 11 goes to logic 0. Also, through gate 13, the 5-second delay circuit is armed and its output goes to logic 0. Through gate 14, the R input of flip-flop 11 goes to logic 1.

(c) Flip-flop 11 changes state and its Q output goes to logic 1.

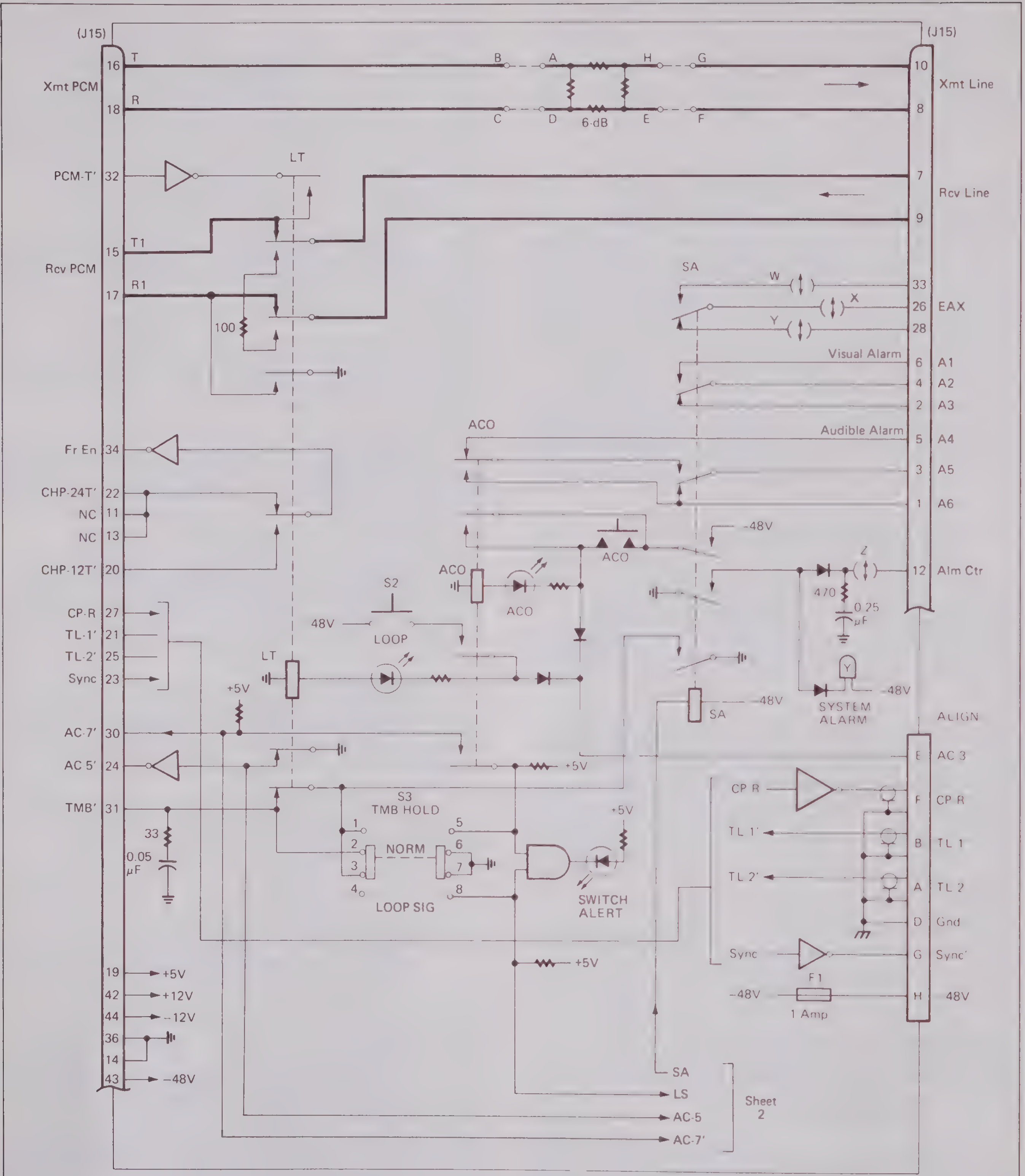
(d) When the 10-second one-shot times out, its inverted output goes from 0 to 1, but flip-flop 11 does not change state. (R and S are both logic 1.)

(e) If gate 13 is not inhibited by Loc, Pwr, or AC-5 through gates 9 and 12, restoral of the 10-second one-shot changes the gate 13 output to logic 1 and the 5-second delay circuit starts timing.

(f) After 5 seconds, the delay circuit output goes back to logic 1. Gate 14 output goes to logic 0 and flip-flop 11 is reset to its normal condition (Q = 0).

(g) However, if there is a remote alarm or an AC-7' test condition, gate 14 is inhibited and flip-flop 11 will not be reset until Rem and AC-7' are normal.

Figure 3-8. Alarm Unit Circuit Diagram (Sheet 1 of 2)


(J15)
(J15)
Xmt PCM
T
16
R
18
B
A
H
G
C
D
6-dB
E
F
10
8
Xmt Line
PCM-T'
32
LT
7
9
Rcv Line
T1
15
Rcv PCM
R1
17
100
SA
W
X
Y
33
26
28
EAX
Visual Alarm
6
4
2
A1
A2
A3
ACO
Audible Alarm
5
3
1
A4
A5
A6
Fr En
34
CHP-24T'
22
NC
11
NC
13
CHP-12T'
20
-48V
ACO
ACO
ACO
Z
12
Alm Ctr
S2
470
0.25 μF
48V
LOOP
CP-R
27
TL-1'
21
TL-2'
25
Sync
23
LT
+5V
Y
-48V
SA
-48V
SYSTEM ALARM
ALIGN
AC-7'
30
AC 5'
24
+5V
E
AC 3
S3
TMB HOLD
CP R
F
CP R
TMB'
31
+5V
1
5
TL 1'
B
TL 1
33
2
NORM
6
0.05 μF
3
7
TL 2'
A
TL 2
4
8
LOOP SIG
SWITCH ALERT
D
Gnd
Sync
G
Sync'
+5V
F1
19
+5V
42
+12V
-48V
H
48V
44
-12V
1 Amp
36
14
43
-48V
SA
LS
AC-5
AC-7'
Sheet 2

NOTES:

1. Relays and Switches. Contacts are shown in normal operating position.
2. External Alarms. Straps W, X, Y, and Z should be open unless EAX and alarm counter circuits are used.
3. Strapping Plugs. Effective with 91230-M3 Issue 9, screw-straps were replaced by strapping plugs. The correspondence between the two types of straps is shown by the example of strap J:

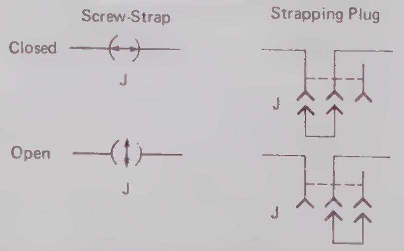
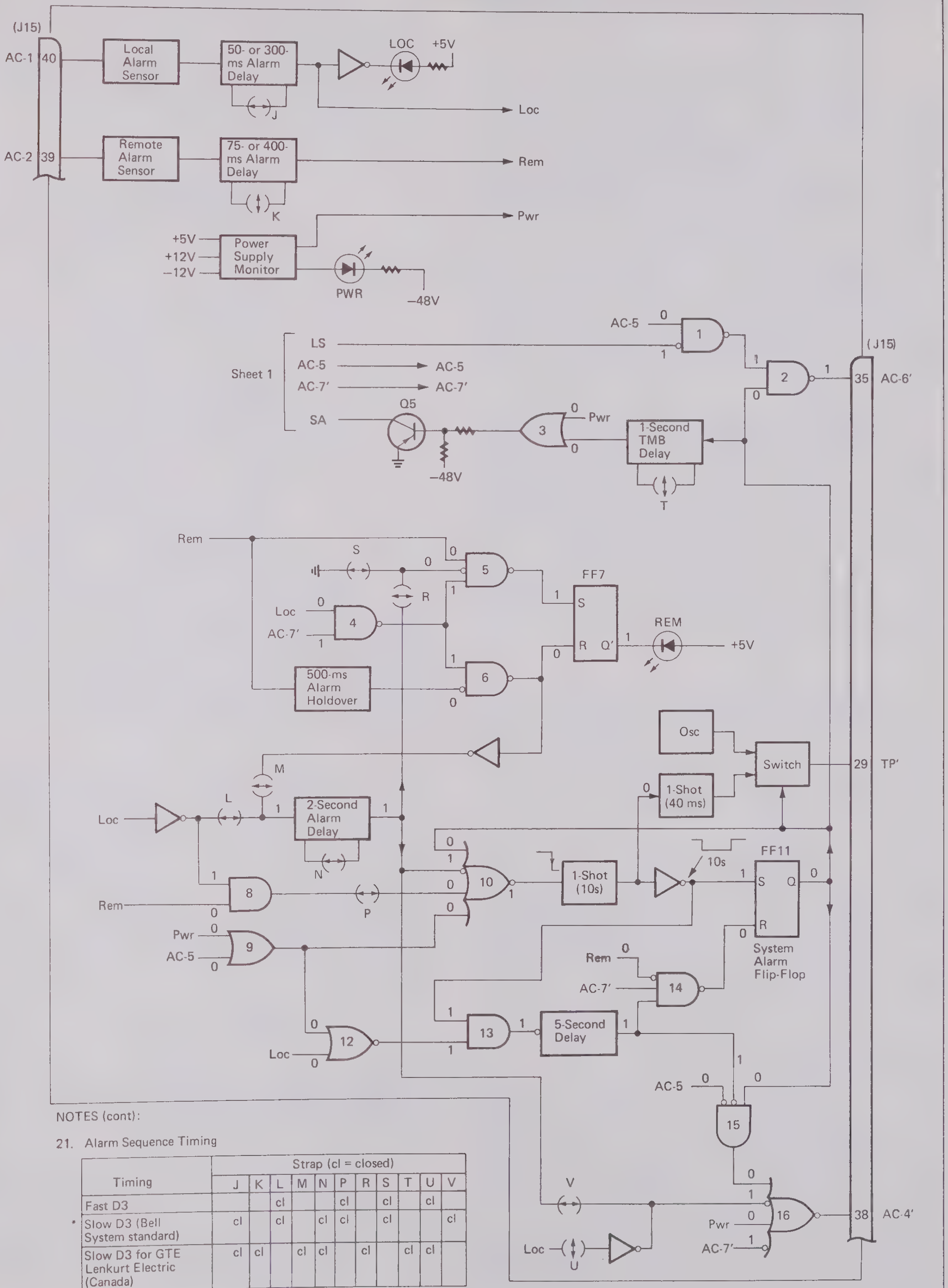

Screw-Strap
Strapping Plug
Closed
J
J
Open
J
J

Figure 3-8. Alarm Unit Circuit Diagram (Sheet 2 of 2)


(J15)
AC-1
40
AC-2
39
Local Alarm Sensor
50- or 300-ms Alarm Delay
J
LOC
+5V
Loc
Remote Alarm Sensor
75- or 400-ms Alarm Delay
K
Rem
Pwr
+5V
+12V
−12V
Power Supply Monitor
PWR
−48V
AC-5
1
LS
Sheet 1
AC-5
AC-7′
SA
Q5
2
AC-6′
35
3
Pwr
1-Second TMB Delay
T
−48V
Rem
S
R
5
FF7
Loc
AC-7′
4
REM
+5V
S
R
Q′
500-ms Alarm Holdover
6
Osc
Switch
29
TP′
1-Shot (40 ms)
M
L
Loc
2-Second Alarm Delay
N
FF11
10s
10
1-Shot (10s)
8
Rem
P
Pwr
AC-5
9
System Alarm Flip-Flop
Rem
AC-7′
14
13
5-Second Delay
12
Loc
AC-5
15
V
16
38
AC-4′
Pwr
AC-7′
Loc
U

NOTES (cont):

21. Alarm Sequence Timing

Timing	Strap (cl = closed)										
	J	K	L	M	N	P	R	S	T	U	V
Fast D3			cl			cl		cl		cl	
* Slow D3 (Bell System standard)	cl		cl		cl	cl		cl			cl
Slow D3 for GTE Lenkurt Electric (Canada)	cl	cl		cl	cl		cl		cl	cl	

*Factory strapping

22. Logic States. Logic states (1 or 0) are shown for normal operating conditions.

(h) At step (e) above, if gate 13 is inhibited, the circuit state is held indefinitely until the alarm clears. Then the 5-second delay takes place before flip-flop 11 is reset.

3.68 Gate 10 responds to a power alarm or loop test condition (AC-5) through gate 9, a local alarm through strap L (with or without a 2-second delay), or a remote alarm through gate 8. In a complete line failure, with both local and remote alarm conditions, gate 8 is inhibited by Loc' at logic 0. This prevents the remote alarm from overriding the 2-second local alarm delay if strap N is closed. Once flip-flop 11 has been set, the Q output at logic 1 holds the gate 10 output at logic 0 to prevent retriggering of the one-shot by intermittent alarms.

3.69 If the alarm unit is strapped for the GTE Lenkurt Electric (Canada) alarm sequence, strap L is open, M is closed, and P is open. Then, gate 10 is controlled by a local alarm through gates 4 and 6, the inverter, strap M, and the 2-second alarm delay. The control path for a remote alarm is the same except it goes through the 500-ms alarm holdover to gate 6.

3.70 Timing Pulses (TP'). In normal operation, via the TP' lead, an oscillator supplies a 60-ms timing pulse every 13 seconds to the channel units. When flip-flop 11 is set (Q = 1), an electronic switch transfers the TP' lead to a 40-ms one-shot that generates a single pulse as the 10-second one shot restores from logic 1 to 0. When flip-flop 11 is reset at the conclusion of the system alarm, the TP' lead is transferred back to the oscillator.

3.71 The function of the single 40-ms pulse is to force certain DPO (dial pulse originating) channel units to an idle state, thereby dropping subscriber connections. After the pulse, the channel units return to the busy state for the duration of the alarm.

3.72 Signaling Control (AC-6'). In a system alarm, through gate 2, the Q output of flip-flop 11 at logic 1 changes AC-6' from logic 1 to logic 0. In the receive unit, this forces channel signaling states on RCS to the on-hook condition. To enable signaling with the channel bank in the loop test mode (AC-5 = 1), slide-switch S3 in LOOP SIG position changes the LS input of gate 1 to logic 0. The gate 1 output goes to logic 0, inhibiting gate 2 and removing the AC-6' alarm condition.

3.73 Bit 2 Transmission (AC-4'). A change from the normal state on any of the four inputs to gate 16 activates AC-4' to inhibit bit 2 transmission; that is, bit 2 in each outgoing channel word is 0. AC-4' is activated to logic 0 immediately in a power alarm or in a local alarm if strap U is closed and V is open. In the optional slow D3 alarm sequence with strap U open, V closed, and N closed, there is a 2-second delay after Loc goes to logic 1.

3.74 AC-4' is also kept activated by AC-7' at logic 0. This occurs during a system alarm condition if the ACO relay is operated and slide-switch S3 is set in the TMB HOLD position.

3.75 In the situations described above, AC-4' is activated until the alarm condition is cleared. A remote alarm, which controls AC-4' through gate 15, inhibits bit 2 transmission for 15 seconds maximum as follows. If the channel bank is not in the loop test mode (AC-5 = 0), the gate 15 output goes to logic 1 when flip-flop 11 is set (Q = 1) and the 5-second delay circuit is armed (output = 0). At the end of the 15-second interval, the output of the 5-second delay circuit restores to logic 1 to inhibit gate 15 and restore AC-4' to logic 1. Flip-flop 11 remains set until the remote alarm condition ends and gate 14 is enabled to provide logic 0 to the flip-flop R input.

3.76 Alarm Delay. In the alarm sequence, there is a short delay from the onset of a local or remote alarm condition to lighting of the LOC or REM indicator. There may be an additional, longer delay to release of the SA relay (SYSTEM ALARM lamp lights) and, for a local alarm, bit 2 suppression to produce a far-end remote alarm. The following optional alarm sequences are selected by straps J through M as shown on sheet 2 of figure 3-8.

(a) Fast D3 sequence:

(1) 300 ms delay to LOC; no additional delay to SA release and bit 2 suppression.

(2) 400 ms delay to REM; no additional delay to SA release.

(b) Slow D3 sequence (Bell System standard):

(1) 50 ms delay to LOC; 2 seconds additional delay to SA release and bit 2 suppression.

(2) 400 ms delay to REM; no additional delay to SA release.

(c) Slow D3 sequence for GTE Lenkurt Electric (Canada):

(1) 50 ms delay to LOC and bit 2 suppression; 3 seconds additional delay to SA release.

(2) 75 ms delay to REM; 3 seconds additional delay to SA release.

3.77 In the slow D3 sequences, the delay to SA release is intended to prevent unnecessary subscriber disconnects when lightning strikes or high-voltage power line faults longer than about 350 ms cause momentary disruption of transmission in the system. If strap T is closed, after 2 seconds, there is an additional 1-second period during which subscribers are disconnected from the channel bank (by AC-6' forcing RCS to on-hook) before SA release activates TMB' to force all channels off-hook.

3.78 Alarm and Restoral Sequence. In the 9002B system, suppression of bit 2 in each channel word of the transmitted signal is the method used by the local channel bank to indicate to the remote channel bank that an alarm condition has been locally detected. Consequently, restoration of the system to normal operation depends upon the reappearance of bit 2 after the alarm condition clears. Restoral is said to be coordinated; that is, both channel banks return to normal operation almost simultaneously. Normally, the channel bank that first detects an alarm condition becomes the master and inhibits transmission of bit 2 to the other channel bank, which becomes the slave.

3.79 The following is an example of an alarm and restoral sequence in which channel bank A has just detected loss of frame synchronization and initiated a local alarm. Refer to the timing diagram, figure 3-9, which pertains to the fast D3 sequence and the slow D3 sequence (Bell System standard). The slow D3 sequence for GTE Lenkurt Electric (Canada) is not shown.

(a) In the receive unit of channel bank A, after 70 ms, channel vf signals are muted and signaling is forced on-hook or off-hook (strap option).

(b) When the local alarm is initiated, after a delay of 300 ms (fast D3 sequence) or 50 ms (slow D3 sequence), the LOC indicator lights.

Figure 3-9. Alarm Unit Timing Diagram

Figure A. Fast D3 Alarm Sequence

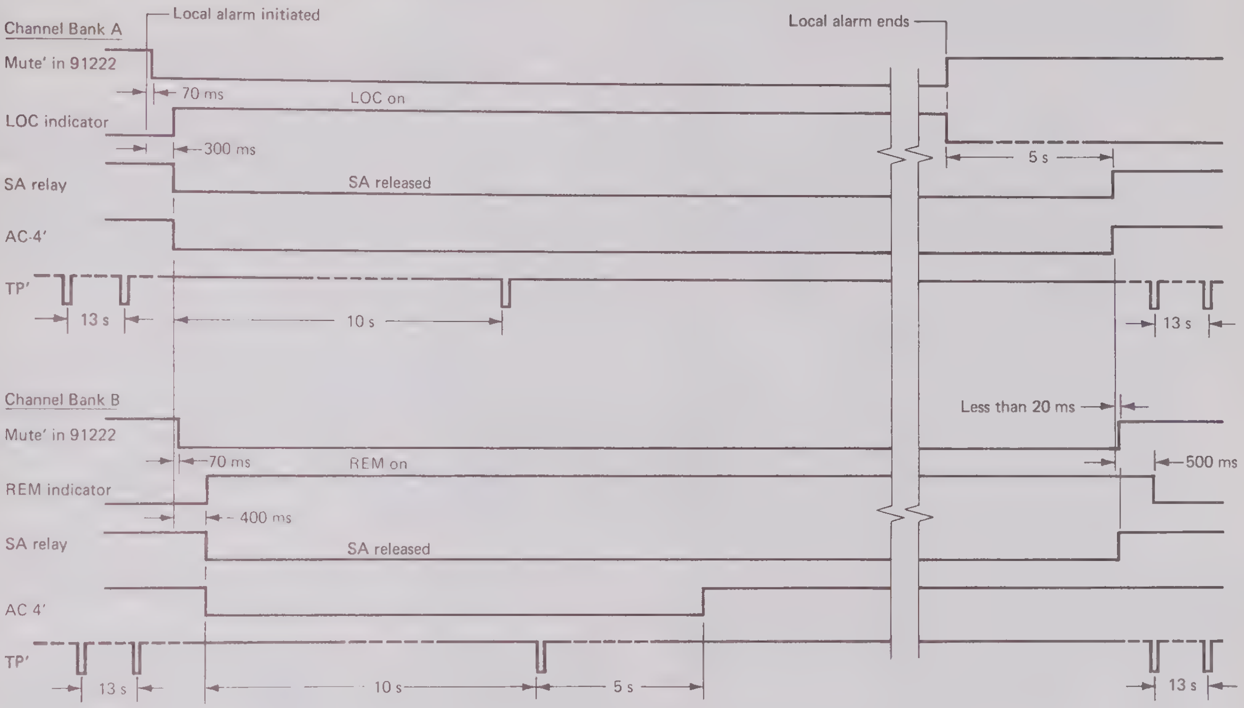
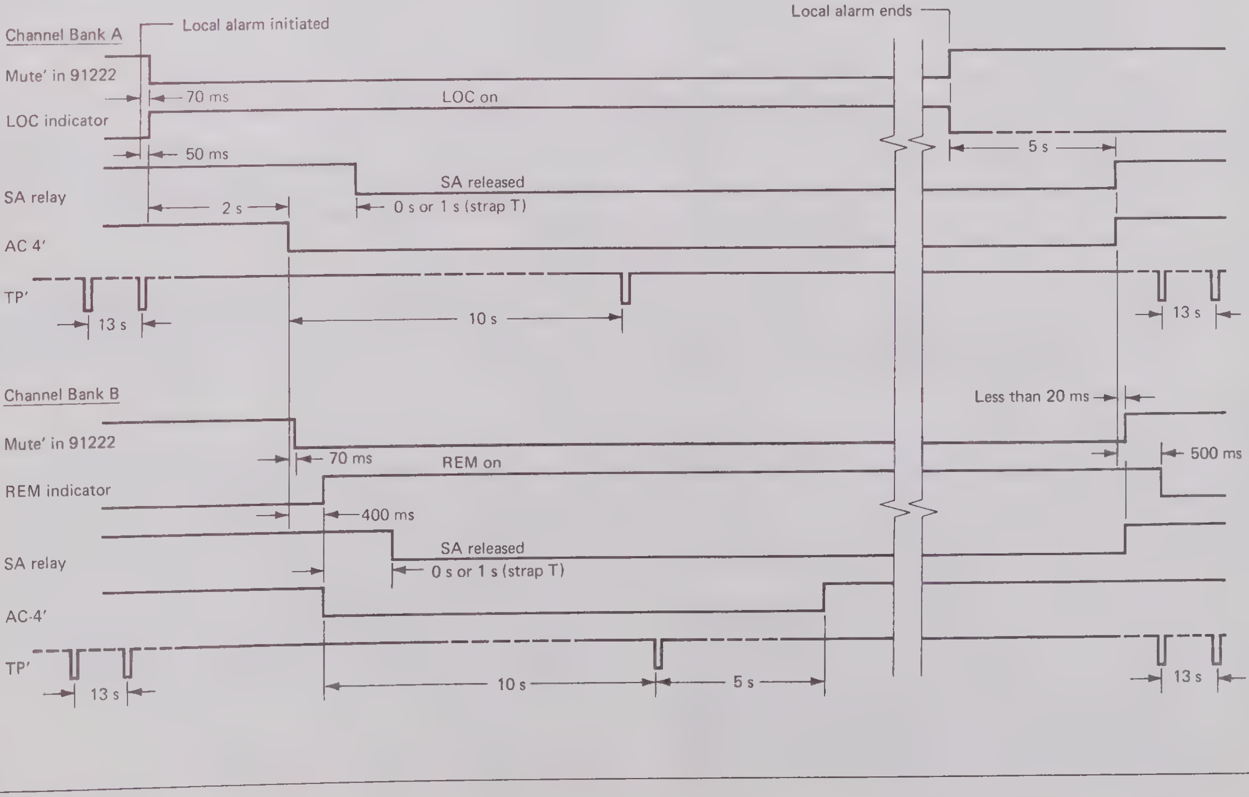

Local alarm initiated
Local alarm ends
Channel Bank A
Mute' in 91222
70 ms
LOC on
LOC indicator
300 ms
5 s
SA relay
SA released
AC-4'
TP'
13 s
10 s
13 s
Channel Bank B
Less than 20 ms
Mute' in 91222
70 ms
REM on
500 ms
REM indicator
400 ms
SA relay
SA released
AC 4'
TP'
13 s
10 s
5 s
13 s

Figure B. Slow D3 Alarm Sequence (Bell System Standard)


Local alarm initiated
Local alarm ends
Channel Bank A
Mute' in 91222
70 ms
LOC on
LOC indicator
50 ms
5 s
SA released
SA relay
2 s
0 s or 1 s (strap T)
AC 4'
TP'
13 s
10 s
13 s
Channel Bank B
Less than 20 ms
Mute' in 91222
70 ms
REM on
500 ms
REM indicator
400 ms
SA released
SA relay
0 s or 1 s (strap T)
AC-4'
TP'
13 s
10 s
5 s
13 s

(c) When LOC lights, AC-4' is activated to inhibit bit 2 transmission and a system alarm is initiated to produce the effects listed below. With the slow D3 sequence (Bell System standard), AC-4' and the system alarm are delayed 2 seconds. With the Canadian slow D3 sequence, only the system alarm is delayed.

(1) AC-6' forces channel signaling to on-hook.

(2) SA relay releases, lighting the SYSTEM ALARM lamp, activating office alarms, and grounding the TMB' (trunk-make-busy) lead to the channel units. With the slow D3 sequences, SA relay release can be delayed for another 1 second by closing strap T.

(3) After 10 seconds, a single 40-ms TP' pulse is sent to all channel units.

NOTE: If the local alarm condition clears before AC-4' inhibits bit 2 transmission, the alarm circuits will restore immediately. If not, the resulting system alarm will continue for the duration of the local alarm condition plus 5 seconds, or for 15 seconds, or until a remote alarm condition ends, whichever is longest.

(d) In the receive unit at channel bank B, loss of bit 2 in the incoming pcm channel words is detected and a remote alarm is initiated. After 70 ms, channel vf signals are muted and signaling is forced on-hook or off-hook (strap option).

(e) When the remote alarm is initiated, after a delay of 400 ms (75 ms for the Canadian slow D3 sequence), the REM indicator lights.

(f) Same as step (c) at channel bank A.

NOTE: Loss of bit 2 is detected at channel bank A but a remote alarm indication is inhibited by the existing local alarm.

(g) At channel bank B, 15 seconds after initiation of the remote alarm, AC-4' restores bit 2 transmission.

(h) At channel bank A, the local alarm clears when frame synchronization takes place. The channel vf signal mute is removed immediately. After a 5-second delay, AC-4' restores bit 2 transmission, AC-6' restores signaling on RCS, and the SA relay operates.

(i) At channel bank B, presence of bit 2 in the receive signal is detected. Within 20 ms, the mute circuit returns to normal, AC-6' restores signaling on RCS, and the SA relay operates. After 500 ms, the REM indicator goes out.

3.80 Loop Test. In a system alarm condition with the ACO relay operated, pressing the LOOP button to the in position lights the LOOP indicator and energizes the LT relay, which does the following:

(a) Terminates the receive span line in 100 ohms.

(b) Connects the unbalanced unipolar transmit signal (PCM-T') to the signal input of the receive unit.

(c) Switches Fr En from CHP-24T' to CHP-12T', synchronizing the channel bank so that there is a 12-channel offset from transmit to receive; for example, in the D3 configuration channel 1 transmits to channel 13.

(d) Through the AC-5' lead, forces the transmit unit to send continuous 1's to the line, thus alarming the remote channel bank (because of no framing pattern) while keeping the repeatered line operational.

(e) Through the AC-5 lead to gates 9 and 15, maintains the existing system alarm condition.

3.81 If the 91232 test set is connected to the alarm unit via the ALIGN connectors, the loop test mode can be established without an existing system alarm condition. With the test set DIGITAL FUNCTION switch in any LOOP position, pressing the test set PUSH TO LOOP TERMINAL button closes —48V to the AC-3' lead. The LT relay and the ACO relay in the alarm unit operate, producing a system alarm and the other effects itemized in the preceding paragraph.

3.82 Slide-Switch S3. In a system alarm condition, TMB' is grounded to busy out the channel units and AC-6' forces RCS to the on-hook state. For loopback testing with the LT relay operated, signaling is enabled by setting slide-switch S3 to LOOP SIG. This opens the TMB' lead and grounds the LS lead to gate 1, restoring AC-6' to logic 1. The SWITCH ALERT indicator lights when S3 is not in NORM position.

NOTE: Because TMB' is not effective when S3 is in LOOP SIG position, channels must be busied out manually during loop signaling tests.

3.83 In a system alarm condition with the ACO relay operated, setting slide-switch S3 to TMB HOLD activates AC-7', which maintains the system alarm by inhibiting gate 14 and maintains bit 2 suppression by activating AC-4' through gate 16. Also, AC-7' causes the transmit unit to switch to internal clock if the unit is strapped for looped receive clock. Now, if the DS1 signal is looped back at a repeatered line patching location, because bit 2 is suppressed, the REM (but not the LOC) indicator will light if the go and return signal paths are okay; otherwise, the LOC (and usually the REM) indicator will light. This test is useful in isolating trouble caused by intermittent or marginal signal conditions on the repeatered line.

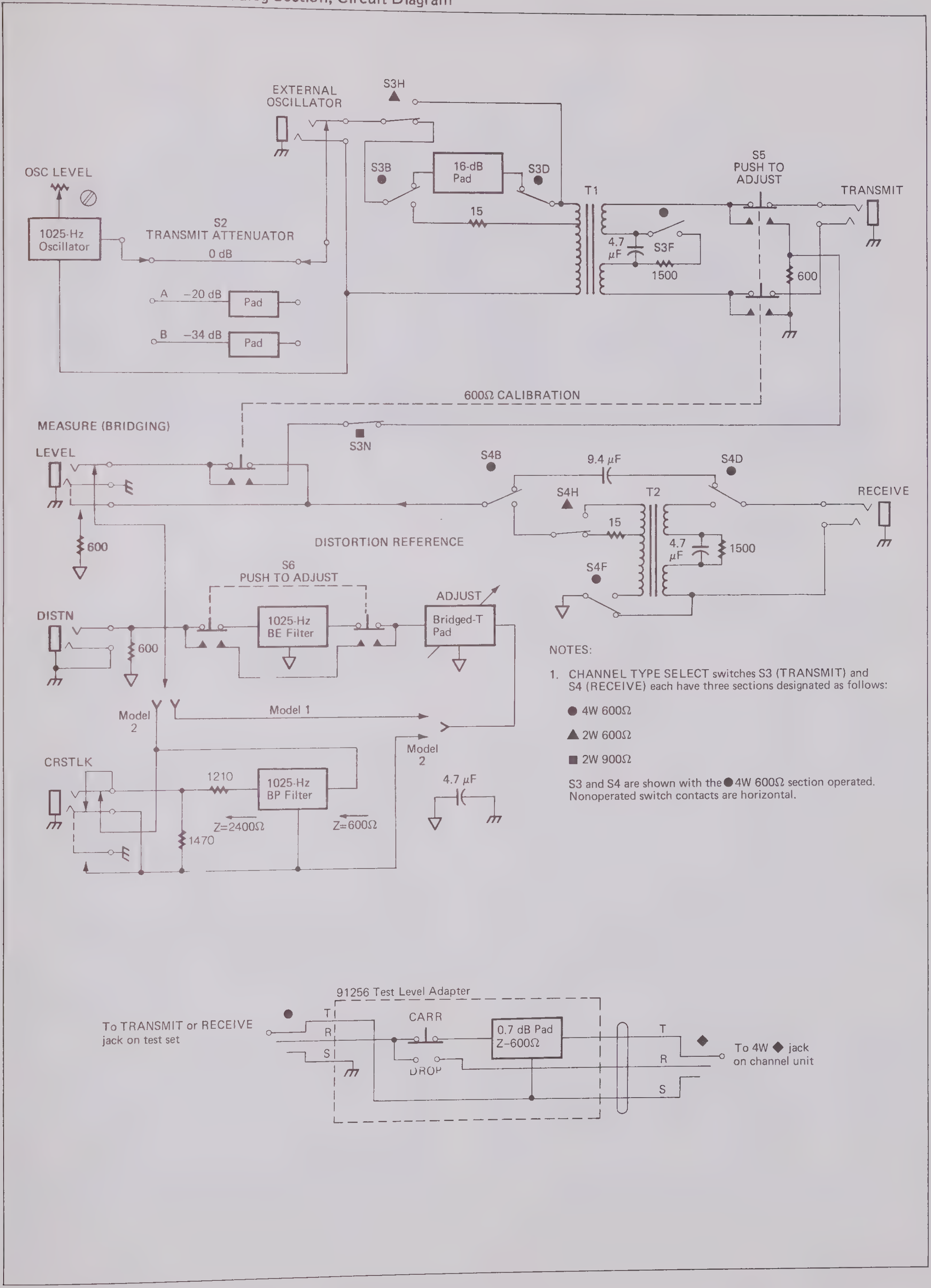
91232 Test Set

3.84 The 91232 Test and Alignment Set has independent analog and digital sections; figures 3-10 and 3-11 are the circuit diagrams. Test set controls and indicators are illustrated and briefly described in figure 3-12.

3.85 Analog Section. The analog section (figure 3-10) provides an interface between external test equipment (acvm, noise measuring set, and signal generator) and the vf jacks on the channel units. It includes a 1025-Hz test tone oscillator, adjustable over a 1-dB range by the OSC LEVEL control.

3.86 In the transmit branch, the output of the 1025-Hz oscillator goes through a three-step transmit attenuator, the normal-through EXTERNAL OSCILLATOR jack, and matching transformer T1 to the TRANSMIT jack. The TRANSMIT CHANNEL TYPE SELECT switch S3 sets the output impedance at 600 ohms or 900 ohms and the level at 0 dBm for two-wire units or —16 dBm for four-wire units if TRANSMIT ATTENUATOR switch S2 is at 0 dB. For distortion measurements, the A and B positions of S2 reduce the levels 20 dB and 34 dB, respectively. Inserting a plug in the EXTERNAL OSCILLATOR jack turns off the 1025-Hz oscillator.

Figure 3-10. 91232 Test Set Analog Section, Circuit Diagram


EXTERNAL OSCILLATOR
S3H
OSC LEVEL
S3B
16-dB Pad
S3D
S5 PUSH TO ADJUST
T1
TRANSMIT
1025-Hz Oscillator
S2 TRANSMIT ATTENUATOR
0 dB
15
4.7 μF
S3F
1500
600
A −20 dB
Pad
B −34 dB
Pad
600Ω CALIBRATION
MEASURE (BRIDGING)
LEVEL
S3N
S4B
9.4 μF
S4D
S4H
T2
RECEIVE
15
600
DISTORTION REFERENCE
4.7 μF
1500
S4F
S6 PUSH TO ADJUST
ADJUST
DISTN
1025-Hz BE Filter
Bridged-T Pad
600
Model 2
Model 1
Model 2
CRSTLK
1210
1025-Hz BP Filter
4.7 μF
Z=2400Ω
Z=600Ω
1470
91256 Test Level Adapter
To TRANSMIT or RECEIVE jack on test set
T
R
S
CARR
DROP
0.7 dB Pad Z-600Ω
T
R
S
To 4W ◆ jack on channel unit

NOTES:

1. CHANNEL TYPE SELECT switches S3 (TRANSMIT) and S4 (RECEIVE) each have three sections designated as follows:

   ● 4W 600Ω

   ▲ 2W 600Ω

   ■ 2W 900Ω

   S3 and S4 are shown with the ● 4W 600Ω section operated. Nonoperated switch contacts are horizontal.

Figure 3-11. 91232 Test Set Digital Section, Circuit Diagram

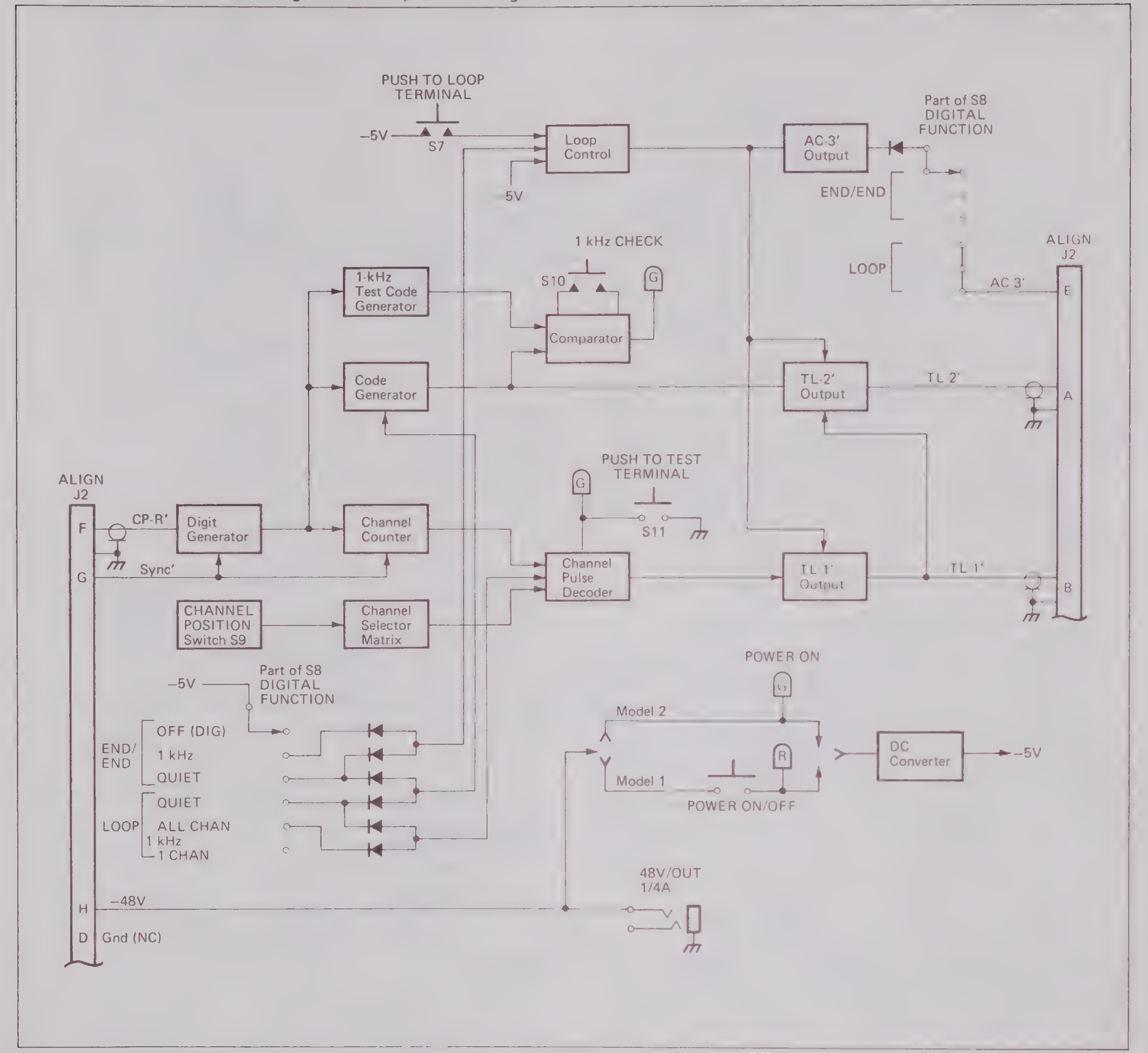
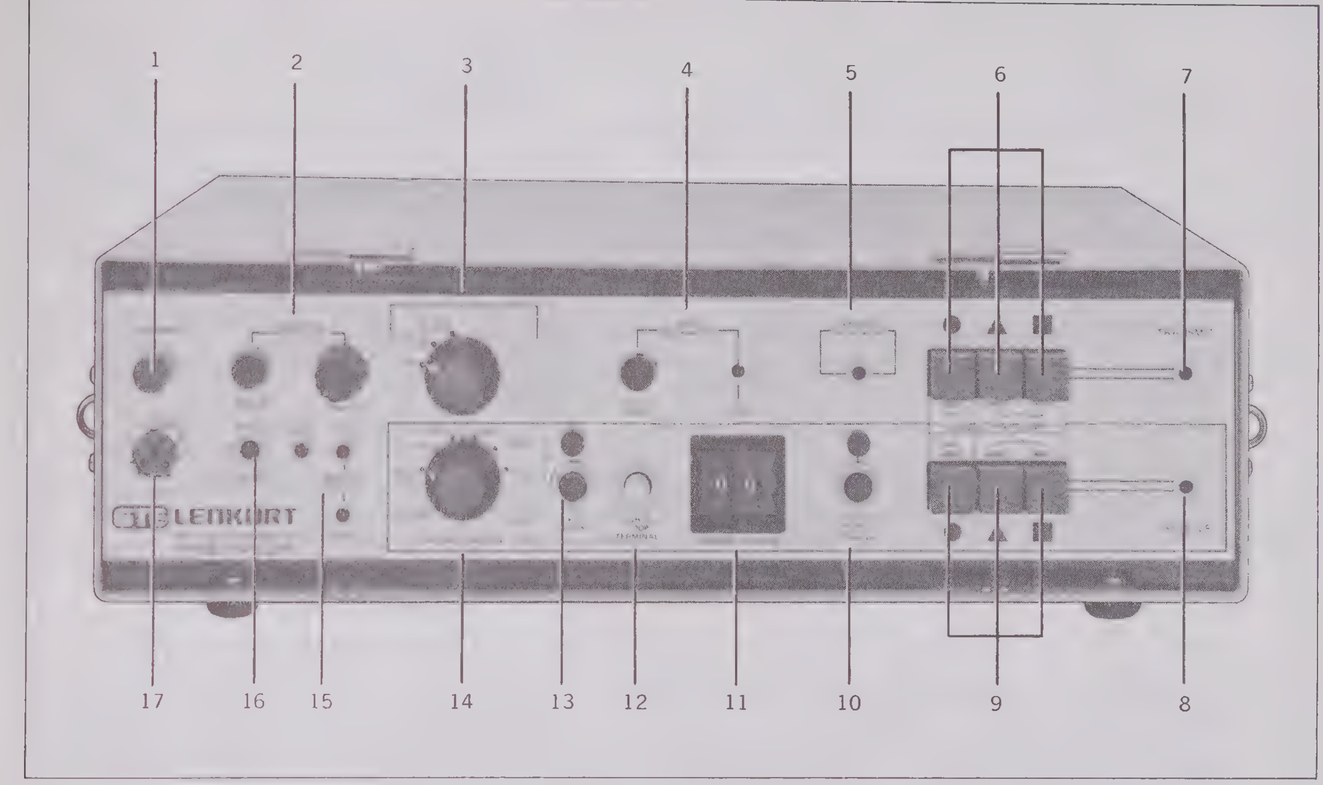

PUSH TO LOOP TERMINAL
–5V
S7
Loop Control
5V
AC-3' Output
Part of S8 DIGITAL FUNCTION
END/END
LOOP
ALIGN J2
AC 3'
E
1 kHz CHECK
S10
G
1-kHz Test Code Generator
Comparator
Code Generator
TL-2' Output
TL 2'
A
PUSH TO TEST TERMINAL
S11
ALIGN J2
F
CP-R'
Digit Generator
Channel Counter
Sync'
G
Channel Pulse Decoder
TL 1' Output
TL 1'
B
CHANNEL POSITION Switch S9
Channel Selector Matrix
–5V
Part of S8 DIGITAL FUNCTION
END/ END
OFF (DIG)
1 kHz
QUIET
LOOP
QUIET
ALL CHAN
1 kHz
1 CHAN
POWER ON
G
Model 2
Model 1
R
POWER ON/OFF
DC Converter
–5V
48V/OUT 1/4A
H
–48V
D
Gnd (NC)

Figure 3-12. 91232 Test Set Controls and Indicators (Sheet 1 of 2)



3.87 When S3 is set at 2W 600Ω or 2W 900Ω a 1500-ohm dc path (holding coil) is inserted in series with the output winding of transformer T1. For setting test-tone levels, with PUSH TO ADJUST switch S5 operated, the output of T1 is terminated in 600 ohms and switched from the TRANSMIT jack to the MEASURE LEVEL jack.

3.88 Beginning at the RECEIVE jack, the receive branch goes through matching transformer T2, the normal-through LEVEL and CRSTLK jacks, the DISTORTION REFERENCE ADJUST pad, and the 1025-Hz band elimination filter to the DISTN jack. In the 4W 600Ω position of CHANNEL TYPE SELECT switch S4, transformer T2 and the 1500-ohm "holding coil" are bypassed. The receive branch is terminated internally, so bridging measurements are made with unterminated test equipment.

3.89 Crosstalk measurements with the model 2 test set are made through a 1025-Hz bandpass filter placed in the receive signal path when the noise measuring set is patched into the CRSTLK jack. With the model 1 test set, which does not include the CRSTLK jack or 1025-Hz bandpass filter, crosstalk measurements are made at the LEVEL jack.

3.90 For distortion measurement on a noise measuring set, the test set is calibrated with the DISTORTION REFERENCE control while receiving a 1025-Hz test tone. When the PUSH TO ADJUST switch S6 is released, the filter blocks the 1025-Hz test tone and the meter indicates relative distortion level.

3.91 Test Level Adapter. The 91256 Test Level Adapter (figure 3-10) is used to patch the TRANSMIT or RECEIVE jack on the test set to the four-wire jacks on certain channel units. A locking-type pushbutton on the 91256 has CARR and DROP positions. Through the 91256, the tip-ring test set circuit is connected to the tip-sleeve (CARR) or ring-sleeve (DROP) circuit at the four-wire jacks. In CARR position, a 0.7-dB pad coordinates the —16/+7 test set levels to the —16.7/+7.7 levels at the carrier side of the four-wire jacks.

3.92 Digital Section. The main function of the digital section (figure 3-11) is to generate a coded pcm signal (TL-2') representing either a 1-kHz channel test tone or a "quiet" channel. This signal is inserted in the digital pulse stream of the 91222 receive unit. Use of the digital section requires that the test set's ALIGN connector be connected through the 035-91232-01 Alignment Cord to the ALIGN connector on the 91230 alarm unit.

3.93 Test-set digit pulses and channel pulses are generated and synchronized by CP-R' and Sync' signals originating in the 91222 receive unit. Channel pulses are decoded to form the TL-1' signal. The channel pulse decoder is enabled by the PUSH TO TEST TERMINAL switch. In the 91222 receive unit, TL-1' inhibits selected time slots in the incoming pcm signal to allow insertion of TL-2' code.

3.94 Logic pulse TL-1' is generated as a negative pulse every 125 μs in the channel time slot selected by CHANNEL POSITION switch S9. However, in two of the LOOP positions (QUIET and 1 kHz ALL CHAN) of DIGITAL FUNCTION switch S8, control by S9 is disabled and TL-1' is a 648-ns positive pulse every 125 μs at S-bit time. This inhibits all of the incoming pcm signal except the S-bit.

NOTE: The CHANNEL POSITION thumbwheel switches (S9) indicate the channel number if the test set is 91232-01 or -02 and the channel sampling se-

Figure 3-12. 91232 Test Set Controls and Indicators (Sheet 2 of 2)

Index	Name	Description	Function
1	POWER ON	Green lamp (model 2 test set)	Lights when test set is connected to 91230 alarm unit through 035-91232-01 Alignment Cord.
	POWER ON/OFF	Pushbutton with red lamp (model 1 test set)	Controls —48V power to test set from 91230 alarm unit; lights when power is on.
2	DISTORTION REFERENCE	Nonlocking pushbutton (S6) and variable attenuator	When PUSH TO ADJUST button is pushed, 1025-Hz band elimination filter is bypassed and ADJUST control sets distortion reference output level at DISTN jack.
3	TRANSMIT ATTENUATOR	Three-position rotary switch (S2)	Attenuates internal 1025-Hz oscillator output level 0 dB, 20 dB, or 34 dB at TRANSMIT jack.
4	600Ω CALIBRATION	Nonlocking pushbutton (S5)	When PUSH TO ADJUST button is pushed, oscillator output is transferred from TRANSMIT jack to LEVEL jack and terminated in 600 ohms. OSC LEVEL is a screwdriver adjustment for internal 1025-Hz oscillator.
5	EXTERNAL OSCILLATOR	Miniature tip-ring-sleeve jack	Input for test tone from an external signal generator in lieu of internal 1025-Hz oscillator.
6	TRANSMIT CHANNEL TYPE SELECT	Interlocking pushbuttons (S3)	Selects impedance and level at TRANSMIT jack as follows: ● 4W 600Ω: —16 dBm ▲ 2W 600Ω: 0 dBm, with holding coil ■ 2W 900Ω: 0 dBm, with holding coil
7	TRANSMIT	Miniature tip-ring-sleeve jack	Oscillator output.
8	RECEIVE	Miniature tip-ring-sleeve jack	Input to measuring circuit.
9	RECEIVE CHANNEL TYPE SELECT	Interlocking pushbuttons (S4)	Selects circuit characteristics at RECEIVE jack as follows: ● 4W 600Ω: unbalanced ▲ 2W 600Ω: balanced, with holding coil ■ 2W 900Ω: balanced, with holding coil
10	PUSH TO TEST TERMINAL	Locking pushbutton (S11) and green lamp	Connects internally-generated digital signals to channel bank under test; lamp lights when pushbutton is in.
11	CHANNEL POSITION	Thumbwheel switches (S9)	Selects channel to be activated by 1-kHz digital code.
12	PUSH TO LOOP TERMINAL	Nonlocking pushbutton (S7)	Loops channel bank when DIGITAL FUNCTION switch is in a LOOP position.
13	1 kHz CHECK	Nonlocking pushbutton (S10) and green lamp	When button is pushed, lamp lights if 1-kHz digital code is being generated.
14	DIGITAL FUNCTION	Six-position rotary switch (S8)	In the two END/END positions, injects a "quiet" digital code or a 1-kHz digital code into a selected channel in the 91222 receive unit. In the three LOOP positions, injects a "quiet" digital code or a 1-kHz digital code into a selected channel or a 1-kHz digital code into all channels in the 91222 receive unit.
15	MEASURE (BRIDGING)	Miniature tip-ring-sleeve jacks	DISTN jack: for measuring distortion through the internal 1025-Hz band elimination filter; jack is terminated in 600 ohms plus 4.7 μF. LEVEL jack: for measuring vf levels; jack is terminated in 600 ohms plus 4.7 μF. CRSTLK jack (mode 2 test set): for measuring crosstalk through the internal 1025-Hz bandpass filter; measure with an unterminated meter.
16	48V/OUT	Tip-ring-sleeve jack	Supplies dc power to external test equipment, —48V on tip and ground on sleeve; fused in 91230 alarm unit.
17	ALIGN	Eight-pin receptacle connector	For connecting test set to 91230 alarm unit through 035-91232-01 Alignment Cord.

quence is D2, or if the test set is 91232-03 or -04 (or -01 or -02 modified per MK3) and the sequence is D3. The settings of S9 for other sequences (including D1D) are tabulated in GTEP Section 342-911-109.

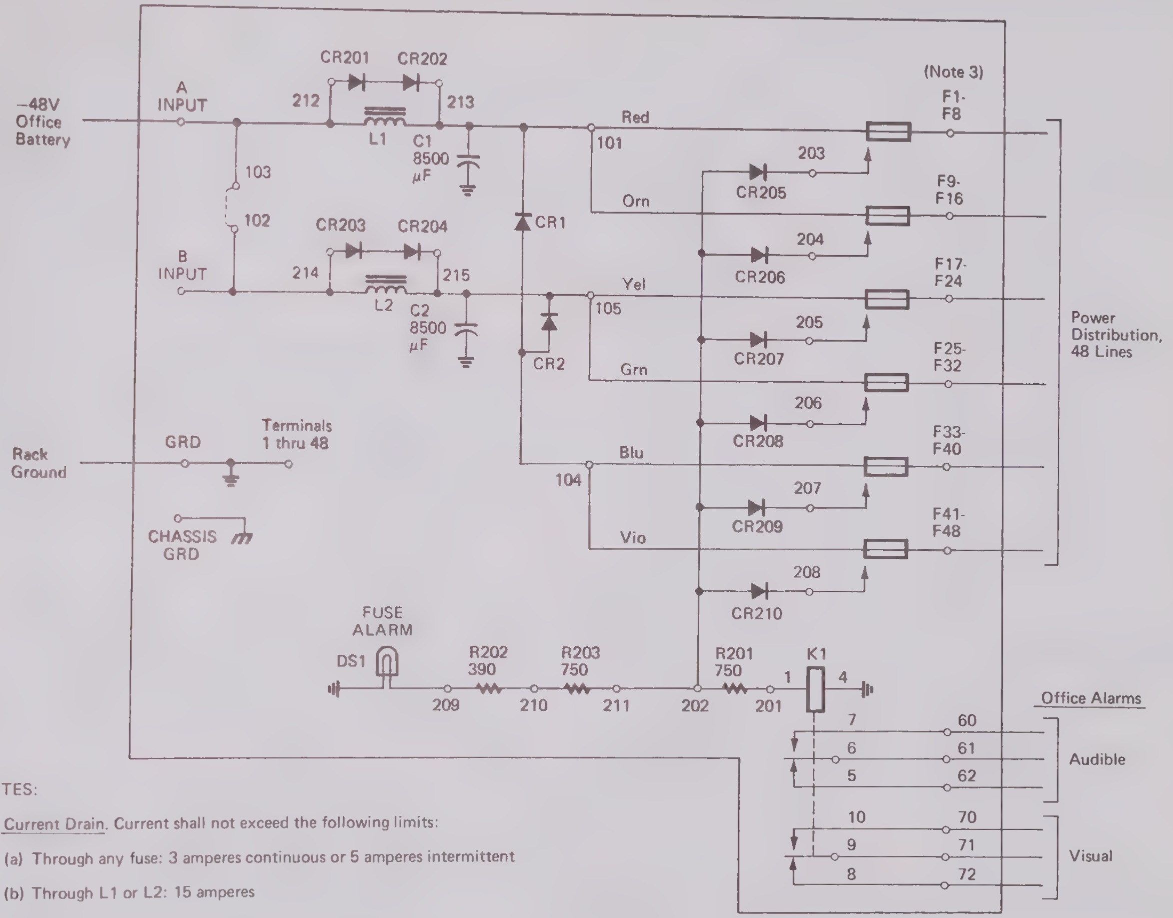
3.95 Depending on the position of DIGITAL FUNCTION switch S8, the code generator produces a digital TL-2' signal representing a 1-kHz channel test tone at 0 dBm0 or a quiet channel. Bits 2 through 8 of the quiet code are logic 1, and bit 1 is alternately logic 1 and logic 0. The code generator output is compared with the output of the 1-kHz test-code generator. When the 1 kHz CHECK button is pushed, the associated green lamp should light if S8 is in any of the three 1-kHz positions.

3.96 The TL-2' output is enabled by the channel pulses in TL-1' so that the 1-kHz or quiet code is injected in the channel selected by S9. However, when S8 is turned to 1 kHz ALL CHAN (LOOP), all channels receive 1-kHz test tone at 0 dBm0.

3.97 The loop control circuit either enables or inhibits the TL-1', TL-2', and AC-3' outputs. When enabled, AC-3' goes to —48 volts and operates the LT and ACO relays in the 91230 alarm unit. With DIGITAL FUNCTION switch S8 in an END/END position, TL-1' and TL-2' are always enabled and AC-3' is open-circuited. With S8 in a LOOP position, the loop control circuit inhibits TL-1', TL-2' and AC-3' until PUSH TO LOOP TERMINAL switch S7 is operated momentarily. The loop control circuit must be reset (by again pushing S7) if power is interrupted or the alignment cord is momentarily disconnected. The latter is detected by interruption of —5V. The loop control circuit is restored by turning S8 to an END/END position.

3.98 Power at —48 volts comes from a 1-ampere fuse on the 91230 alarm unit through the alignment cord.

Figure 3-13. 46820 Power Filter and Fuse Panel, Circuit Diagram


–48V Office Battery
A INPUT
212
CR201
CR202
213
L1
C1 8500 µF
Red
101
103
102
CR203
CR204
B INPUT
214
215
L2
C2 8500 µF
CR1
CR2
Yel
105
Orn
Grn
Blu
104
Vio
(Note 3)
F1-F8
F9-F16
F17-F24
F25-F32
F33-F40
F41-F48
203
204
205
206
207
208
CR205
CR206
CR207
CR208
CR209
CR210
Power Distribution, 48 Lines
Rack Ground
GRD
Terminals 1 thru 48
CHASSIS GRD
FUSE ALARM
DS1
R202 390
R203 750
R201 750
209
210
211
202
201
K1
1
4
7
6
5
10
9
8
60
61
62
70
71
72
Office Alarms
Audible
Visual

NOTES:

1. Current Drain. Current shall not exceed the following limits:
   - (a) Through any fuse: 3 amperes continuous or 5 amperes intermittent
   - (b) Through L1 or L2: 15 amperes
   - (c) Through terminal 104: 7 amperes
   - (d) Total load: 40 amperes (assumes one or more fuse groups transferred to terminal 102 or 103; see paragraph 3.100)
2. Input Power Options. Circuit is shown strapped for a single –48V input at A. Other strapping options are as follows:
   - (a) –24V input: strap 201-202 and 210-211 (behind front panel)
   - (b) Two inputs: remove strap 102-103 and connect inputs to A and B
   - (c) Tandem filters: remove strap 102-103, strap 101-102, and connect a single input to A.
3. Fuses F1 through F48. One fuse is shown as typical for each group of eight. Alarm contacts of the eight fuses are connected together.
4. Relay Contacts. Relay K1 contacts are rated for a noninductive load of 1 ampere at 24 Vdc or 0.5 ampere at 48 Vdc.
5. Terminals. Input and ground terminals accommodate 14 AWG to 6 AWG wire. Output and alarm terminals are wirewrap type.
6. Fuses. Fuses (GMT type) and color dots that identify fuse ratings are not furnished with the 46820 panel and must be ordered separately.

Fuse		Color Dot	
Rating, Amperes	GTE Lenkurt Stock No. 175-28996	Color	GTE Lenkurt Stock No. 125-37804
0.18	-04	Yellow	-07
1/4	-05	Violet	-09
1/2	-09	Red	-05
3/4	-06	Brown	-04
1	-01	Gray	-10
1-1/3	-02	White	-11
2	-03	Orange	-06
3	-07	Blue	-08
*5	-10	Green	-12
7-1/2	-12	Black-White	
10	-08	Red-White	

*Standard for 9002 channel bank.

FILTER ATTENUATION CHARACTERISTICS

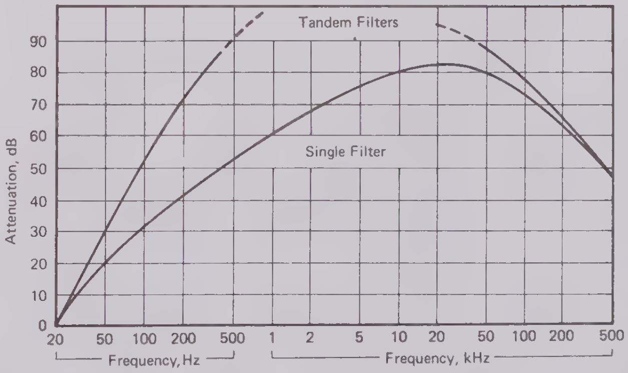
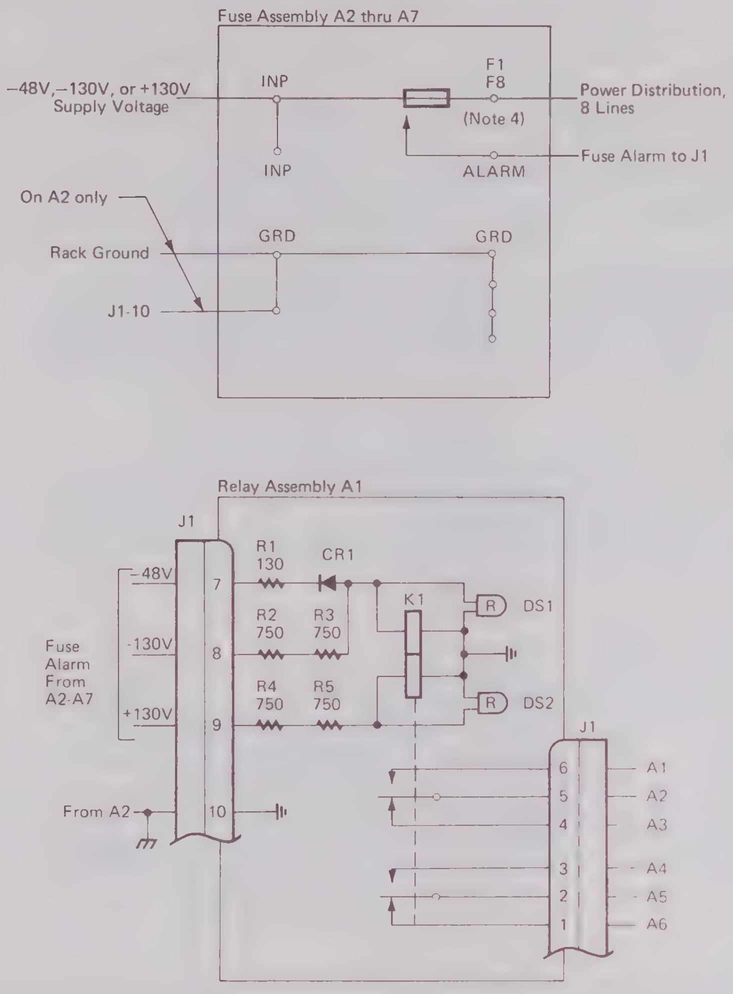


Figure 3-14. 91155 Fuse and Alarm Shelf, Circuit Diagram


Fuse Assembly A2 thru A7
−48V,−130V, or +130V Supply Voltage
INP
F1
F8
(Note 4)
Power Distribution, 8 Lines
Fuse Alarm to J1
INP
ALARM
On A2 only
GRD
GRD
Rack Ground
J1-10
Relay Assembly A1
J1
R1 130
CR1
−48V
7
K1
DS1
R2 750
R3 750
Fuse Alarm From A2-A7
-130V
8
R
R4 750
R5 750
+130V
9
R
DS2
J1
6
A1
5
A2
4
A3
From A2
10
3
A4
2
A5
1
A6

NOTES:

1. Assembly designations A1 through A7 are assigned from left to right as viewed from the front.
2. The total current drain of all fuse assemblies in the shelf should not exceed 40 amperes.
3. Connect ALARM terminal on A2 through A7 to J1-7, -8, or -9, as applicable.
4. One fuse is shown as typical for F1 through F8. Alarm contacts are connected together.
5. Fuses are not furnished with the fuse assembly and must be ordered separately.

Fuse Rating, Amperes	Color	GTE Lenkurt Stock No. 175-28996
0.18	Yellow	-04
1/4	Violet	05
1/2	Red	-09
3/4	Brown	06
1	Gray	01
1-1/3	White	02
2	Orange	03
3	Blue	07
*5	Green	10
7-1/2	Black-White	12
10	Red-White	08

*Standard for 9002 channel banks.

Maximum load is about 400 mA. An additional 250 mA may be furnished to external dc-powered test equipment through the 48V/OUT jack.

46820 Power Filter and Fuse Panel (figure 3-13)

3.99 The 46820 panel distributes —48V office battery through 48 GMT alarm-type fuses to channel banks and associated equipment. Two power filters, L1-C1 and L2-C2, attenuate power, voice, and carrier frequencies that may be present on the office battery supply lead. By strapping, the filters can be operated independently or in tandem. For circuits requiring standby protection, two independent —48V inputs can be combined through diodes CR1 and CR2.

3.100 Figure 3-13 shows two fuse-groups (eight fuses in each group) connected to the filter outputs at terminals 101 and 105 and to the diode-combined outputs at terminal 104. Before installation, other arrangements can be made by transferring the color-coded leads at terminals 101, 105, and 104. Fuse-groups can also be connected to terminal 102 or 103 for distribution of unfiltered dc power.

3.101 A blown fuse operates relay K1 and lights the FUSE ALARM lamp. Dry contacts on K1 are available for connection to audible and visual office alarm circuits.

91155 Fuse and Alarm Shelf (figure 3-14)

3.102 The 91155 shelf can be equipped with up to six plug-in fuse assemblies, A2 through A7. Each assembly distributes —48V, —130V, or +130V through eight GMT alarm-type fuses. (—130V and +130V are required by certain paystation channel units in a 910A system.) The input supply voltage can be multipled between adjacent assemblies by strapping together the INP terminals.

3.103 Plug-in relay assembly A1 is part of the shelf. Fuse alarm circuits from A2 through A7 are jumpered to the applicable voltage terminal on J1 (pin 7, 8, or 9). When a fuse blows, relay K1 operates and DS1 or DS2 lights. Dry contacts on K1 are available for connection to audible and visual office alarm circuits.

4. ENGINEERING CONSIDERATIONS

Standard Rack Assemblies

4.01 The standard rack assemblies described in Part 6 represent the configurations available from the factory. For example, four 9002B PCM Channel Banks comprising 96 voice channels, a fuse and alarm shelf, and a jackstrip multiple may be mounted on an 8-foot rack. Also, six channel banks, a test set, a fuse and alarm shelf, and a jackstrip multiple may be mounted on an 11-foot, 6-inch rack. When channel banks are furnished as loose equipment, they may be assembled to present the same profiles as the standard assemblies.

Spare Equipment Shelf

4.02 A 91330 shelf may be used to maintain spare units in operation by supplying 48-volt power to the shelf and installing jumpers on the alarm unit receptacle connector (J15) to loop back the DS1 line signal. The alarm indicators then reflect the operating condition of the common equipment. The jumpers need not be removed to perform the looped-terminal tests described in Section 342-911-109.

Channel Units

4.03 Preferably, the channel banks should be fully equipped and all channels maintained as though assigned for service. Operation with fewer than two channel units in the upper level of the shelf and two in the lower level is not recommended because of a possible increase in idle channel noise when the common equipment is lightly loaded.

4.04 There are no restrictions on channel tone loading. Interchannel crosstalk will be within specification at normal data or sf (single-frequency) tone levels. In applications using sf signaling where inband signaling is on during the talking period, the originating end will experience idle noise at approximately the 35-dBrnc0 level.

Equipment Location

4.05 The channel bank and accessory equipment should be located in an area of the office that provides adequate lighting and working space. Rear access is required for installation and maintenance. Ambient temperature and relative humidity should not exceed the limits specified in the Technical Summary. The channel bank must not be mounted near sources of excessive heat such as furnace outlets, or above heat producing units such as power supplies or tube-type equipment. Dusty environments must be avoided.

4.06 Where possible, install the equipment at least 6 feet from strong magnetic fields and sources of switching impulse noise that may be coupled into the circuits of the channel bank. Where space is limited, it is sometimes possible to reduce the radiation effect of such sources by physically reorienting them in relation to the pcm equipment.

Power Requirements

4.07 Channel bank dc power is obtained from the 48-volt office battery. Three lower voltages (+5V, +12V, and —12V) are derived from —48V by the 91235-02 Power Supply Unit and distributed to the common equipment units and the channel units. The 91230 alarm unit and many channel units also use —48V directly.

4.08 Figure 4-1 illustrates how to calculate the load on the office battery for a particular 9002B channel bank configuration. The figure shows the current drain with no channel units plugged in (800 mA) and the additional current drain produced by each type of channel unit. The value listed for a DPO or FXS channel unit does not include current to the external loop; this must be estimated and entered in the space provided.

2.06

Figure 4-1. Sample Calculation of 9002B Channel Bank Load on Office Battery

Channel Unit		Qty of Units	Total Current, mA
Type	mA/Unit		
Common equipment			800
91234 4W SF 91237 2W DX 91240 4W E&M	16 26 25		
91241 2W E&M 91242 4W	24 15		
91243 DPO Loop current	30 -------		
91250 Stop Dial/Wink 91251 ETS-4 91252 2W E&M	30 20 25		
91253 DPO Loop current	40 100	12	480 1200
91254-01 4W E&M 91254-02 4W E&M 91255-01 DPT	11 20 28		
91255-02 DPT 91257 4W Tandem 91258 FXO	28 33 75	6	168
91259 FXS Loop current	82 70	6	492 420
91290 DPO/ICT	28 -------		
91291 DPT/OGT	33		3.56A
Total load on office battery			

NOTES:

1. Currents are based on office battery at 52 volts.
2. Loop currents are to be based on actual operating conditions. Loop resistance in channel unit is about 400 ohms.

4.09 For channel units that require talking battery, the noise on the battery supply leads should not exceed the 30-dBrnc objective stated in Section 331-310-510. If battery noise exceeds this objective, either the battery noise must be reduced or the battery supply leads filtered to hold impulse noise and idle channel noise within specification. Suitable filters may be mounted in the cable runs. A selection is provided in Section 786-300-070.

4.10 Alternatively, a 46820 Power Filter and Fuse Panel can be mounted on the equipment rack. As an example, a six-terminal rack of equipment with a maximum current requirement of 30 amperes might be equipped with the 46820 panel or with GTE Automatic Electric H-887641-3 and circuit H-850076-A97A, as determined from Section 786-300-070. Similarly, a three-terminal rack requiring a maximum of 15 amperes could be equipped with the 46820 panel or with GTE Automatic Electric H-887641-1 and circuit H-850076-A99A.

4.11 Rack power wiring should be adequate to handle the largest expected currents while maintaining at least 44 volts at the channel bank. Wire sizes should be calculated according to the criteria presented in Section 795-001-070 and with consideration that a channel bank could be expected to be fused for a worst case load up to 4 amperes.

4.12 Office battery ground return leads must be capable of handling currents up to 5 amperes per channel bank, assuming 24 E-leads drawing current. The office battery ground return cable is connected to the solderless ground lug mounted on the equipment rack. A ground wire of at least 16 AWG is to be connected from terminal E1 on the 91330 shelf to the equipment rack in accordance with GTEP Section 795-805-073.

4.13 For a complete rack of six 9002B channel banks to draw 24 amperes of current, the absolute worst case condition must exist; namely, that all 144 channel units in the rack are DPO units connected to very short subscriber loops and simultaneously calling for service. The probability of this condition ever occurring is extremely remote. A typical busy-hour load for a fully equipped 11'6" bay containing 50-percent E&M channel units and 50-percent loop channel units is 18 amperes. Power wire based on this typical busy hour load at 48 Vdc should be more than adequate even in times of extremely heavy circuit demands.

Office Alarms

4.14 Form C contacts on the channel bank system alarm relay are provided to control audible and visual office alarms. The contact rating for noninductive loads is 1 ampere at 48 Vdc. To increase contact life and, more important, to suppress electrical noise, a contact protection circuit is required for an inductive load current over 10 mA or a load inductance greater than 0.5 henry. The protection circuit should be installed as close as possible to the inductive load.

4.15 The system alarm relay has another set of form C contacts for use by an electronic exchange and an open/ground contact for controlling an external alarm counter. Contact protection is required if the counter is inductive.

4.16 Contact rating of the fuse alarm relays on the 46820 panel and the 91155 shelf, for noninductive loads, is 1/2 ampere (46820) or 1 ampere (91155).

Office Drop Wiring

4.17 Five pin-pairs on the channel unit shelf connectors (J1-J12 and J17-J28) are preassigned to the vf and signaling/supervisory circuits of the office equipment; for example, pins 42 and 44 are the T1 and R1 leads of a four-wire receive circuit. To minimize coupling between circuits, in cabling the channel units to the office equipment, a separate 25-pair cable should be allocated to each pin-pair. See figure 8-3.

4.18 On the 91330-01 shelf, office cables terminate directly on the wirewrap terminals of the channel unit shelf connectors. On the 91330-02 shelf, the five channel unit pin-pairs are factory-wired to five 50-pin male connectors, J30 through J34. Interface with the office equipment is made through 163-10315-xx or 163-10316-xx Cable Assemblies, which have 50-pin female connectors.

4.19 On the 91330-03 shelf, which is for 91251 ETS-4 Channel Units, the interface is as described above for the -02 shelf except J32 is not used. In addition, three leads (ETS-4 Gnd, SMG, and ETS-4 Bat.) must be run from the ETS-4 machine to the channel bank.

4.20 The 91330-04 shelf is similar to the -02 shelf except the circuits wired to J30 through J34 are particularly for the 91238 No. 2 EAX Channel Unit. In addition, ringback tone (RBT) must be run from the No. 2 EAX machine to TB1-7 on the channel bank.

4.21 Vf and signaling/supervisory circuits from the 91330-02 or -03 shelf can be routed through the connectorized versions of the 5215B Miniature Jackfield Assembly (GTEP Section 342-521-100). Interconnections are made with the cable assemblies cited above and with 163-10312-08 Cable Assembly Adapters. See figures 5-2 and 8-4.

Optional Strapping

4.22 Flexibility of the 9002B PCM Channel Bank is achieved by means of built-in strap options described below and tabulated on the circuit diagrams.

4.23 Terminal Equipment Shelf. All channel unit receptacle connectors on the 91330 Terminal Equipment Shelf are equipped with switching contacts (31-32 and 33-34) to close trunk make-busy circuits when the channel unit is removed from the shelf. When required, TMB strapping of the supervisory leads is done at the wirewrap terminals on the connectors as shown in figure 8-3.

4.24 Terminal board TB2 has a factory-installed strapping link between terminals 2 and 3 that connects Fr-Sync timing pulses to subscriber channel units. The strapping has no effect on channel units in trunk, toll-connecting, or intertoll applications. The link is removed when the channel bank transmit timing is controlled by an external clock.

4.25 If the channel bank is to operate in the looped receive clock mode, the link is moved to connect terminals 1 and 3 of TB2.

NOTE: Strapping on TB2 must agree with strapping on the transmit unit. Otherwise, system alarm cycling can result.

4.26 Transmit Unit. The 91221 Transmit Common Equipment Unit is strapped for one of three clock sources: a clock within the transmit unit, the receive clock looped to the transmit unit, or an external clock. When the transmit unit is used in a channel bank with certain subscriber channel units, the unit is strapped for internal clock and Fr Sync pulse distribution. The looped or external clock options cannot be used in this application.

4.27 The transmit unit also has the option of (1) normal signaling on the vf channels via shared bit 8 or (2) no signaling. The no-signaling option is available for future use with common channel interoffice signaling (CCIS) equipment.

4.28 Wire-strap terminals A, B, C, D, and E are intended for future CCIS applications. Present equipment configurations require that these terminals not be strapped.

4.29 Receive Unit. A strapping option of the 91222 Receive Common Equipment Unit enables either an on-hook or off-hook supervisory signal to be present in all channel units during frame search or a remote alarm condition. The unit is strapped for on-hook conditioning of the channel units in 910A Subscriber Carrier systems and channel banks used for extended area service (EAS) trunks. The unit is strapped for off-hook conditioning in channel banks used for toll-connecting and intertoll trunks.

4.30 Once a system alarm condition is reached, the signaling states of individual channels may be controlled by channel unit design or strapping.

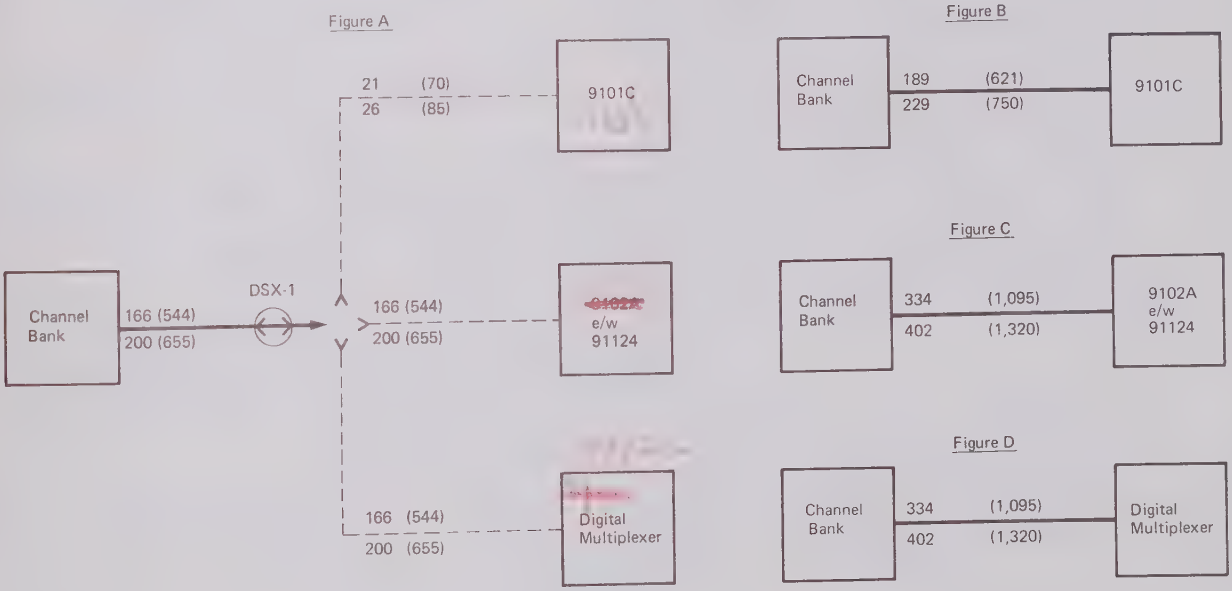
4.31 Wire-strap terminals D, E, F and H are for future applications. They should not be strapped in present applications.

4.32 Alarm Unit. The 91230 Alarm and Control Unit can be strapped to operate in one of three alarm sequences (paragraph 3.76). The unit is shipped from the factory strapped for the slow D3 sequence, which corresponds to the Bell System D3 compatibility requirements. It is recommended that the unit remain strapped for this option even though two other options are available. The advantage of the slow D3 sequence is lost unless the option exists at both ends of the system. Nevertheless, use of the

Figure 4-2. DS1 Cable Lengths and Cable Equalizers

Cable From Channel Bank to	Figure	Length of Cable in Metres		Length of Cable in Feet		Cable Equalizer in Channel Bank
		GTS-8507	GTS-8510 or ABAM	GTS-8507	GTS-8510 or ABAM	
DSX-1 cross-connect	A	0 to 14 14 to 90 90 to 166	0 to 17 17 to 108 108 to 200	0 to 46 46 to 294 294 to 544	0 to 55 55 to 355 355 to 655	No equalizer 087-53258-02 087-53259-02
9101C (91101 Line Terminating Shelf); DSX-1 not used	B	0 to 37 37 to 113 113 to 189	0 to 46 46 to 137 137 to 229	0 to 123 123 to 371 371 to 621	0 to 150 150 to 450 450 to 750	No equalizer 087-53258-02 087-53259-02
9102A (91140 Line Terminating Shelf equipped with 91124 Office Terminating Repeater Unit); DSX-1 not used	C	0 to 182 182 to 258 258 to 334	0 to 219 219 to 311 311 to 402	0 to 597 597 to 845 845 to 1,095	0 to 720 720 to 1,020 1,020 to 1,320	No equalizer 087-53258-02 087-53259-02
Digital multiplexer; DSX-1 not used	D					

NOTE:
In Figures A thru D, maximum cable lengths in metres (feet) are shown above and below the lines, respectively, for GTS-8507 and GTS-8510 or ABAM cable.



option in no way prevents compatible operation of the 9002B channel bank on an end-to-end basis with 9002A, D1D, D2, or D3 channel banks using the fast D3 sequence. The channel bank with the shorter delay will initiate the system alarm cycle.

4.33 Provision is also made in the alarm unit to remove a 6-dB pad and insert one of two cable equalizers into the transmit line. See paragraph 4.38.

4.34 Channel Units. Strapping information for channel units is contained in Section 342-911-104 (910A System) and the Sections listed in figure 1-2.

DS1 Cables

4.35 The DS1 transmit and receive signals of the 9002B channel banks may be cabled in the same multipair shielded cable. Separation of the DS1 cabling and vf cabling is not necessary from an electrical standpoint but is recommended for physical protection of the pairs. Shielded cable should not be laced to the cable rack or cable rings. If lacing is necessary, the stitches should be loosely tied so that indentations are not made in the cable. Tight stitching could deform the cable sufficiently to change its electrical characteristics and, in extreme cases, might cause a shield-to-conductor short. When cable ties are used to secure cables to hexagonal studs, the studs must first be insulated to prevent possible short circuits.

4.36 To prevent ground loops, DS1 cable shields are usually grounded at the channel bank end only. Under special circumstances, field experience may indicate a need to ground the shield at both ends of the cable. Shield connections should be routed to the office ground in as short a distance as possible.

4.37 In this publication, reference is made to two types of shielded cable for DS1 signals.

(a) GTE Specification GTS-8507: high-frequency terminating cable with 1, 5, 8, 10, or 12 individually shielded 22-gauge pairs; manufactured by General Cable Corp. as type 4162.

(b) GTE Specification GTS-8510 or WECo ABAM: multipair cable having unshielded 22-gauge pairs within a common shield; manufactured by General Cable Corp. as type 4155.

DS1 Cable Equalizers

4.38 Figure 4-2 shows the maximum lengths of DS1 cable between the channel bank and a line terminating shelf or a digital multiplexer, connected directly or through a DSX-1 cross-connect. As shipped from the factory, the 91230 alarm unit has a 6-dB pad strapped in the DS1 transmit signal path. For the longer lengths of DS1 cable, the straps are removed and a cable equalizer (087-53258-02 or 087-53259-02) is installed in the circuit in place of the pad. The cable equalizer, which must be ordered separately, is shipped loose for field installation.

4.39 Because of design differences in their DS1 input circuits, a channel bank and a digital multiplexer cabled directly together may not require the same type of equalizer.

4.40 As described in GTEP Section 342-910-103, a spare line driving signal can be derived from the channel bank DS1 transmit output by a 91108 PCM Signal Power Divider. The DS1 signal from the 91221 transmit unit is wired directly to the 91108, where it divides into two paths (one to the spare line) with a 6-dB loss in each path. Because of the 6-dB loss and because the 91230 alarm unit is bypassed, this application cannot be used if the channel bank requires a cable equalizer.

see add. 2.04

5. EQUIPMENT IDENTIFICATION

5.01 Figure 5-1 lists the 9002B equipment in type number order and gives a brief description of each item. For channel units, refer to GTEP Section 342-911-108. For standard configurations of the channel bank and standard rack assemblies of three to six channel banks, see Part 6.

5.02 Ancillary equipment used with but not part of the channel bank is described in figure 5-2.

5.03 Figure 5-3 lists test equipment recommended for installation, alignment, and maintenance of the channel bank. Equivalent items may be substituted.

5.04 Figure 5-4 lists replaceable parts, including plug-in units, that might be needed in on-site maintenance. Recommended spare parts with minimum quantities per site are identified in the table.

5.05 The following special tools are furnished with each 91330 Terminal Equipment Shelf:

(a) Extractor 020-55382-01 (for channel units)
(b) Extractor 020-56788-01 (for strapping plugs)

Figure 5-1. 9002B PCM Channel Bank Components

Type No.	Model	Name	Description
91221-01	3	Transmit Common Equipment Unit	In the transmit direction, converts vf and signaling information on 24 channels into a 1.544-Mb/s bipolar pcm signal.
91222-01	4	Receive Common Equipment Unit	In the receive direction, processes the incoming 1.544-Mb/s bipolar pcm signal to recover vf and signaling information for 24 channels.
91230-01	3	Alarm and Control Unit	Monitors dc power, receive synchronization, and integrity of incoming signal; monitors bit 2 of the incoming signal to determine alarm condition at the remote terminal; controls office alarms; controls DS1 loopback testing; supplies power and control signals to 91232 test set via ALIGN receptacle connector; supplies timing and control signals to channel units during alarm condition or loopback test mode; includes a 5-dB pad in the DS1 transmit output, which may be replaced by one of two cable equalizers depending on cable length and type as shown in figure 4-1. Code AA Cable Equalizer 087-53258-02 AB Cable Equalizer 087-53259-02
91235-02	3	Power Supply Unit	From a —48V input, supplies three regulated dc voltages to units of the 91330 shelf. Voltages and maximum loads are +5V at 2.5A, +12V at 1A, and —12V at 1A.
91330-XX	1	Terminal Equipment Shelf	Provides mounting and electrical interconnections for four plug-in common equipment units and 24 plug-in channel units. -01 External vf and signaling/supervisory circuits connect to wirewrap terminals on channel unit receptacle connectors J1-J12 and J17-J28. -02 External vf and signaling/supervisory circuits connect to five 50-pin male receptacle connectors (J30-J34) via 25-pair cable assemblies 163-10315-XX or 163-10316-XX. -03 Similar to -02 except J32 is not used; for ETS-4 applications only. -04 Similar to -02 except vf and signaling/supervisory circuits wired to J30-J34 are particularly for 91238 No. 2 EAX Channel Units; other channel units except 91234, 91251, and subscriber-end channel units of the 910A system can be operated in this shelf. Channel sampling sequence is D3 only.
91333-XX	1	Channel Pulse Adapter Unit	Inserted in channel pulse distribution between receptacle connector J29 and plug connector P1; arranges channel bank for other than D3 channel sampling sequence. -01 D1D sequence -02 D2 sequence

Figure 5-2. Ancillary Equipment

Type No.	Model	Name	Description
5215B-XX	1	Miniature Jackfield Assembly	One mounting space connectorized jackfield equipped with up to 96 single or 48 double miniature telephone jacks. See GTEP Section 342-521-100. -22 Normal-through jacks and monitor jacks for 24 four-wire vf channels; line and drop sides of jacks are wired to four chassis-mounted 50-pin connectors. See figure 8-4 for application. -24 Normal-through jacks for E&M circuits of 48 channels; C/OS leads go through auxiliary switching contacts on jacks; line and drop sides of jacks are wired to six chassis-mounted 50-pin connectors; two 163-10312-08 Cable Assembly Adapters are required. See figure 8-4 for application. -25 Bell System standard interbay patch jacks (mod, demod, and sig) for 24 channels; line and drop sides of jacks are wired to six chassis-mounted 50-pin connectors; includes unwired jacks for access to battery, ground and milliwatt supply. In a typical application, one jackfield is installed on the center rack of a three-rack group. Jackfields of adjacent three-rack groups are connected by three 163-10316-XX Cable Assemblies. This provides 24 six-wire patching paths accessible to all channels on the racks. The jackfields are not cabled to the channel banks and therefore the 91330 shelf may be -01, -02, or -03. -26 Same as -25 except wired per GTE Lenkurt standard. -27 Normal-through jacks for A/B leads of 48 channels; line and drop sides of jacks are wired to four chassis-mounted 50-pin connectors. See figure 8-4 for application. -43 Normal-through jacks for E&M circuits of 24 channels; type I, II, or III signaling interface; line and drop sides of jacks are wired to four chassis-mounted 50-pin connectors; SG and SB leads are wired directly between connectors without going through jacks. See figure 8-4 for application. Code AC Two brackets that extend jackfield 4-1/8 inches from rack.
46820-01	1	Power Filter and Fuse Panel	Distributes —48V at 40 amperes maximum through up to 48 GMT alarm-type fuses at 5 amperes maximum per fuse; fuses not included; has an LC filter in each of the two —48V input circuits.
56620-01	1	Writing Shelf	One mounting space unit that can be installed as a writing shelf or a storage drawer.
91065-01	1	Counter Panel	Rack-mounted chassis (one vertical space) that accommodates up to 11 counters (Code A). Code A Three-digit electromechanical totalizing counter with mechanical reset button; nominal operating voltage, 48 volts dc; coil resistance, 2,000 ohms ±10%; maximum counting speed, 20 impulses/second; minimum off time between impulses, 25 ms.
91155-01	1	Fuse and Alarm Shelf	Mounting for six Code A fuse assemblies; includes plug-in office alarm relay assembly. Code A One fuse assembly that distributes —48V, —130V, or +130V through eight GMT alarm-type fuses; fuses not included.
163-10312-08	-	Cable Assembly Adapter	Two 50-pin female connectors wired to two 50-pin male connectors by a 50-pair, 24-gauge cable 18" long; each pair from a female connector is split so that tip and ring leads go to corresponding pins on the two male connectors; used to split supervisory leads to 5215B jackfield.
163-10315-XX	—	Cable Assembly	25-pair, 24-gauge cable with 50-pin female connector on one end, length as listed below; mates with J30 through J34 on 91330-02 or -03 shelf. -05 25 feet -25 125 feet -45 225 feet -10 50 feet -30 150 feet -50 250 feet -15 75 feet -35 175 feet -55 275 feet -20 100 feet -40 200 feet -60 300 feet
163-10316-XX	-	Cable Assembly	25-pair, 24-gauge cable with two 50-pin connectors, male on one end and female on the other, length as listed below; female connector mates with J30 thru J34 on 91330-02 or -03 shelf. -01 5 feet -10 50 feet -35 175 feet -02 10 feet -15 75 feet -40 200 feet -03 15 feet -20 100 feet -45 225 feet -04 20 feet -25 125 feet -50 250 feet -05 25 feet -30 150 feet -55 275 feet -60 300 feet
163-10352-09	—	Connectorized Terminal Block	10 x 25 terminal block for installation on MDF; wirewrap terminals 1 x 1.4 mm (0.040 x 0.055 inch); five 50-pin female connectors. See figure 8-4 for application.

Figure 5-3, Recommended Test Equipment

Qty per Site	Test Equipment (GTE Lenkurt unless otherwise specified)	Notes	Description and Use
1	91232-XX Test and Alignment Set		Supplies 1025-Hz analog test tone to channel unit vf jacks; provides interface between external test equipment and channel unit vf jacks; inserts digital test signals for selected channels in the receive 1.544-Mb/s bit stream; furnishes —48V at 0.25A to external equipment. The test set may be rack-mounting or portable and the numbering of the CHANNEL POSITION thumbwheel switches may conform to the D2 or D3 channel sampling sequence as follows: -01 Rack-mounting; D2 sequence -02 Portable; D2 sequence -03 Rack-mounting; D3 sequence -04 Portable; D3 sequence Includes Alignment Cord 035-91232-01, 2.7 metres (9 feet) long for interconnection with channel bank, and the following plugs and cords: 6000A-01 600-Ohm Terminating Plug 6000A-02 900-Ohm Terminating Plug 6100B-02 Cord (qty 2) 6100C-02 Cord (qty 2) 6100D-02 Cord Rack-mounted test set can serve three standard rack assemblies; cords furnished with test set are long enough to reach channel banks in adjacent bay on either side.
1	91249-01 Channel Unit Extender	1	For troubleshooting.
1	91249-02 Channel Unit Extender	1, 2	For testing.
2	91256 Test Level Adapter	3	Used to connect 91232 test set to four-wire jacks on certain channel units; coordinates test tone levels and jack circuits.
1	26600 Signaling Test Set		Sends signaling pulses at selected rate and percent break; receives signaling pulses and measures percent break.
1	Northeast Electronics TTS-37B Noise Measuring Set		Noise and level measuring test set with switch-type weighting networks and hold coil; for level measurements more accurate than ±0.25 dB, use Hewlett-Packard 400EL ACVM, or equivalent.
1	Northeast Electronics TTS-58A (or TTS-58A-CN) Impulse Noise Counter		Counts number of impulses exceeding a selected level over a selected time interval.
1	Hewlett-Packard 204C Oscillator	4	For frequency response tests, 200 to 3400 Hz at 0 dBm.
1	Simpson 260-6 Volt-Ohm-Milliammeter		General purpose multimeter with 20,000-ohms/volt sensitivity.
1	725A Cord		Two-conductor cable 3.6 metres (12 feet) long wired between tip and sleeve of two 310-type tip-ring-sleeve telephone plugs; used to supply —48V power to 26600, TTS-37B, and TTS-58A.
1	729A Cord		Shielded two-conductor cable 2.4 metres (8 feet) long with a twin pin plug on one end and a 310-type tip-ring-sleeve telephone plug on the other end; for connecting to channel unit pin jacks.
1	792B Cord 792-B [illegible]		Shielded two-conductor cable 2.4 metres (8 feet) long with a twin pin plug on one end and a miniature tip-ring-sleeve telephone plug on the other end; for connecting to channel unit pin jacks.
1	6000A-01 600-Ohm Terminating Plug	5,6	Miniature telephone plug with a 600-ohm resistor between tip and ring.
1	6000A-02 900-Ohm Terminating Plug		Miniature telephone plug with a 900-ohm resistor between tip and ring.
2	6100B-02 Cord	5	Shielded two-conductor cable 3.0 metres (10 feet) long with a miniature tip-ring-sleeve telephone plug on one end and a twin banana plug on the other end; equivalent to 6000B-02.
2	6100C-02 Cord		Shielded two-conductor cable 3.0 metres (10 feet) long with a miniature tip-ring-sleeve telephone plug on each end; equivalent to 6000C-02.
1	6100D-02 Cord		Shielded two-conductor cable 3.0 metres (10 feet) long with a 310-type tip-ring-sleeve telephone plug on one end and a miniature tip-ring-sleeve telephone plug on the other end; equivalent to 6000D-02.
24	141-54484-01 Open Plug		Dummy (plastic) miniature telephone plug.

NOTES:

1. Refer to GTEP Section 342-911-108 for description and circuit diagram.
2. 91249-02 Channel Unit Extender is required with the following channel units:
   91243
   91250
   91253-02 M2
3. 91256 Test Level Adapter is required with model 1 of the following channel units:
   91252-01, -02
   91253
   91254
   91255
   91257
   91258
   91259
4. Frequency response tests are not applicable to all channel unit types; refer to GTEP Section 342-911-109.
5. Furnished with 91232 Test and Alignment Set.
6. One 600-ohm terminating plug is required for each 91241-04 channel unit; one 900-ohm terminating plug is required for each 91241-02 or 91245-01 channel unit. Maximum quantity recommended is 24.
7. GTEP Section 032-201-150 gives a complete listing and description of GTE Lenkurt test cords, plugs, and adapters.

Figure 5-4. Replaceable Parts

Item	Ordering No.	Quantity Used	Recommended Spares, Minimum Per Site
Common equipment units (91221-01, 91222-01, 91230-01, and 91235-02)	91300-02	1 set	1 set for 1 to 20 channel banks
Channel unit	See figure 1-2	24 maximum	1 per channel bank
91330 Terminal Equipment Shelf			
Bracket, rear cover (supersedes rear cover retainer clip 026-56424-01)	020-56766-01	4	
Screw, thread-cutting, 8-18 x 1/4 (attaches rear cover bracket)	125-10483-45	8	
Connector, receptacle, 44-pin (J1-J12, J17-J28)	140-53300-12	24	
Connector, receptacle, 44-pin (J13-J16)	140-53300-03	4	
Cover, front, plastic	022-54866-01	1	
Cover, rear, plastic	022-53119-03	2	
Extractor, channel unit	022-55382-01	1	
Extractor, strapping plug	020-56788-01	1	
Label, "9002B Channel Bank"	023-53768-03	1	
Label, channel assignment	023--54407-01	1	
Network, suppression	087-55496-01	4	
91230 Alarm and Control Unit			
Fuse, type GMT, 1A	175-28996-01	1	10
Lamp	184-10955-28	1	2
Lens, amber	138-56416-02	1	
91235-02 Power Supply Unit			
Fuse, type GMT, 2A	175-28996-03	1	10
91232 Test and Alignment Set	91232-03 or -04	1	1
46820 Power Filter and Fuse Panel			
Fuses	See figure 3-13		10
Capacitor, electrolytic; 8500 µF, 75 Vdcw	159-20839-73	2	
Diode, silicon, power; 1N3209R (CR1, CR2)	174-20988-12	2	
Diode, silicon, power; 1N4383 (CR201-CR210)	174-19529-10	10	
Lamp, with red lens; 10V, 36mA, ASA 2174D	138-52952-01	1	2
Relay, 24V, 700Ω	185-44357-01	1	
Resistor, fixed, wirewound; 750Ω ±5%, 3 watts (R201, R203)	169-43152-17	2	
Resistor, fixed, composition; 390Ω ±5%, 1 watt (R202)	160-03903-43	1	
91155 Fuse and Alarm Shelf			
Fuse assembly (code A)	090-91155-42	6 maximum	
Fuses	See figure 3-14		10
Diode, silicon, power; 1N4385	174-19529-12	1	2
Lamp, 48V	084-91155-01	2	
Relay	185-47857-01	1	
Resistor, fixed, flameproof; 130Ω ±1%, 2 watt	169-43000-20	1	
Resistor, fixed, flameproof; 750Ω ±5%, 5 watt	169-43002-52	4	

6. STANDARD ASSEMBLIES

6.01 Standard rack arrangements of three to six channel banks can be ordered as 91300-XX assemblies, which are described and illustrated in figure 6-1. Ordering numbers are listed for the rack assemblies, for several versions of the 91330 shelf, and for a loose set of common equipment units.

6.02 In addition to the ordering number (91300-XX), the rack type and height must be specified; see figure 6-2. Rack assemblies in figure 6-1 are on minimum height racks; if a taller rack is ordered, the equipment will occupy the same mounting positions shown.

6.03 Plug-in units for the channel bank and fuses for the 46820 panel or the 91155 shelf are not included with the standard rack assemblies and must be ordered separately. See figure 3-13 or 3-14 for fuse listings.

6.04 Power distribution and alarm circuits on the standard rack assemblies are factory-wired as shown in figure 6-3.

(Text continues on page 39.)

Figure 6-1. Standard Assemblies (Sheet 1 of 4)

see add 2.10

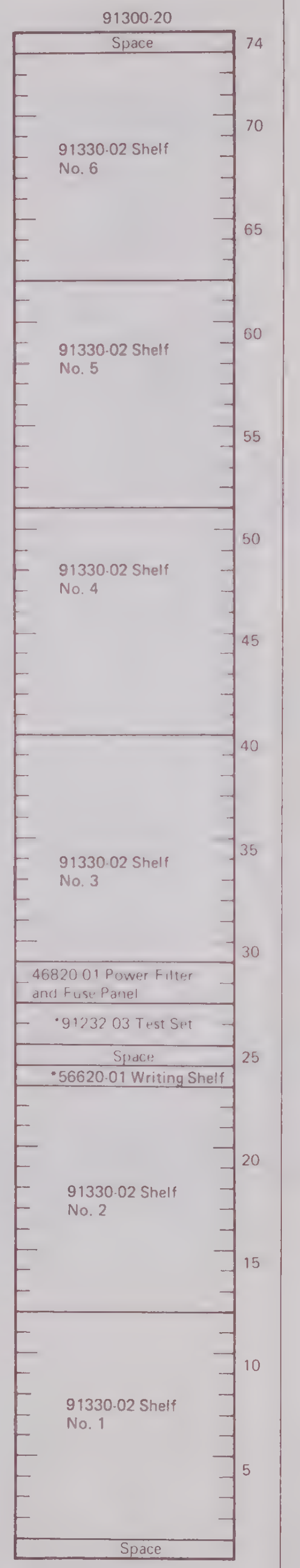
Ordering Number 91300-XX	Description	Minimum Rack Height	Channels	91330-XX Terminal Equipment Shelf, Quantity (Note 2)			Power Distribution
				-01	02	03	
-01	91330-01 shelf and one set of common equipment units (Note 1)		24	1			
-02	One set of common equipment units (Note 1)						
-03	91330-03 shelf and one set of common equipment units (Note 1); for ETS-4 applications		24			1	
04	91330-02 shelf and one set of common equipment units (Note 1)		24		1		
-20	Rack assembly	11′-6″ or 11′-8″	144		6		46820-01
-21	Rack assembly	11′-6″ or 11′-8″	144		6		91155-01 (Note 3)
-22	Rack assembly	11′-6″ or 11′-8″	120		5		46820-01
23	Rack assembly	11′-6″ or 11′-8″	120		5		91155-01 (Note 3)
24	Rack assembly; for ETS-4 applications	11′-6″ or 11′-8″	144			6	91155-01 (Note 3)
-25	Rack assembly	11′6″ or 11′8″	144		6		91155-01 (Note 3)
-32	Rack assembly; used with 91300-33 or -34	7′	96		4		
-33	Rack assembly	7′	72		3		91155-01 (Note 3)
34	Rack assembly	7′	72		3		46820-01
41	Rack assembly	11′-6″ or 11′-8″	144		6		91155-01 (Note 3)
-42	Rack assembly	9′	96		4		91155-01 (Note 3)
-43	Rack assembly	9′	96		4		46820-01
-44	Rack assenbly	8′	96		4		46820-01
-45	Rack assembly	8′	96		4		91155-01 (Note 3)

Notes:

1. A set of common equipment units consists of one of each of the following:

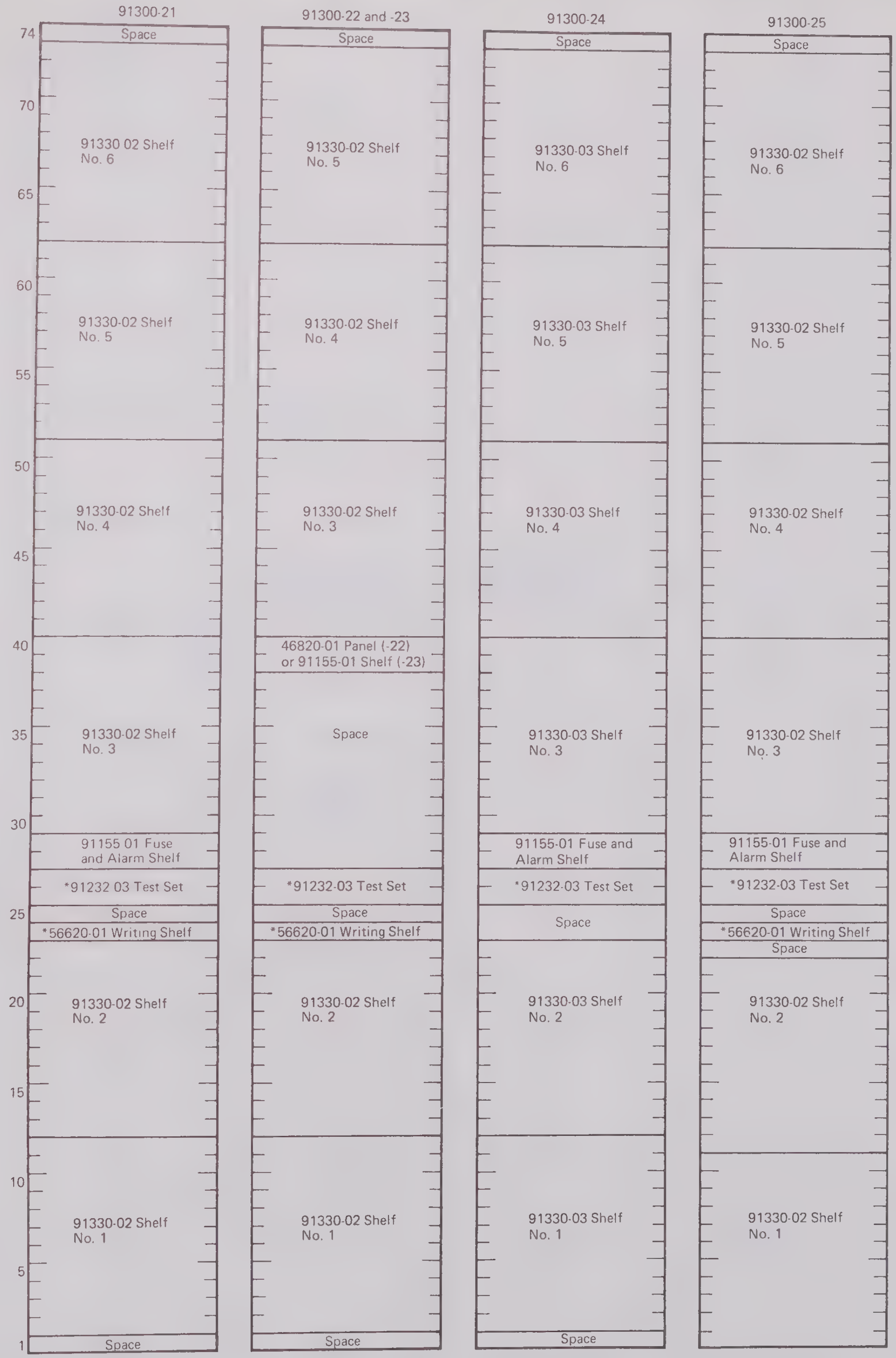
   91221-01 Transmit Common Equipment Unit
   91222-01 Receive Common Equipment Unit
   91230-01 Alarm and Control Unit
   91235-02 Power Supply Unit

2. Unless otherwise specified, 91330 shelves are not equipped with plug-in units. On the 91330-02, -03, and -04 shelves, channel vf and signaling/supervisory leads are brought out to four or five 50-pin male connectors mounted on the rear of the shelf.
3. The 91155-01 Fuse and Alarm Shelf is equipped with one Code A fuse assembly, except on the 91300-33 rack assembly it is equipped with two.
4. Power distribution and alarm circuits are factory-wired on the rack assemblies.


91300-20
Space
91330-02 Shelf No. 6
91330-02 Shelf No. 5
91330-02 Shelf No. 4
91330-02 Shelf No. 3
46820-01 Power Filter and Fuse Panel
*91232-03 Test Set
Space
*56620-01 Writing Shelf
91330-02 Shelf No. 2
91330-02 Shelf No. 1
Space
74
70
65
60
55
50
45
40
35
30
25
20
15
10
5

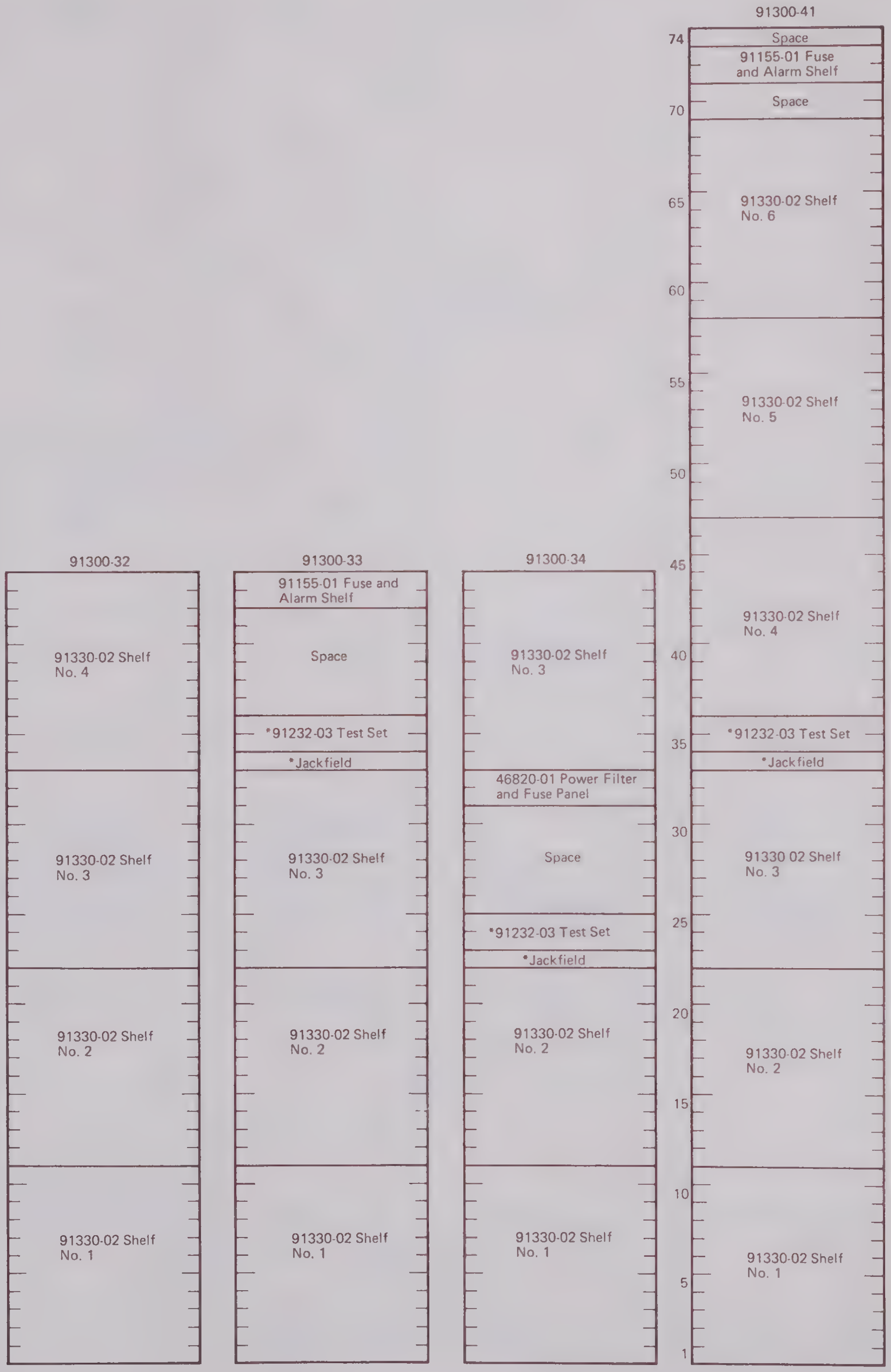
*Not included in standard assembly; order separately.

Figure 6-1. Standard Assemblies (Sheet 2 of 4)


91300-21
Space
91330 02 Shelf No. 6
91330-02 Shelf No. 5
91330-02 Shelf No. 4
91330-02 Shelf No. 3
91155 01 Fuse and Alarm Shelf
*91232 03 Test Set
Space
*56620-01 Writing Shelf
91330-02 Shelf No. 2
91330-02 Shelf No. 1
Space
91300-22 and -23
Space
91330-02 Shelf No. 5
91330-02 Shelf No. 4
91330-02 Shelf No. 3
46820-01 Panel (-22) or 91155-01 Shelf (-23)
Space
*91232-03 Test Set
Space
*56620-01 Writing Shelf
91330-02 Shelf No. 2
91330-02 Shelf No. 1
Space
91300-24
Space
91330-03 Shelf No. 6
91330-03 Shelf No. 5
91330-03 Shelf No. 4
91330-03 Shelf No. 3
91155-01 Fuse and Alarm Shelf
*91232-03 Test Set
Space
91330-03 Shelf No. 2
91330-03 Shelf No. 1
Space
91300-25
Space
91330-02 Shelf No. 6
91330-02 Shelf No. 5
91330-02 Shelf No. 4
91330-02 Shelf No. 3
91155-01 Fuse and Alarm Shelf
*91232-03 Test Set
Space
*56620-01 Writing Shelf
Space
91330-02 Shelf No. 2
91330-02 Shelf No. 1
74
70
65
60
55
50
45
40
35
30
25
20
15
10
5
1

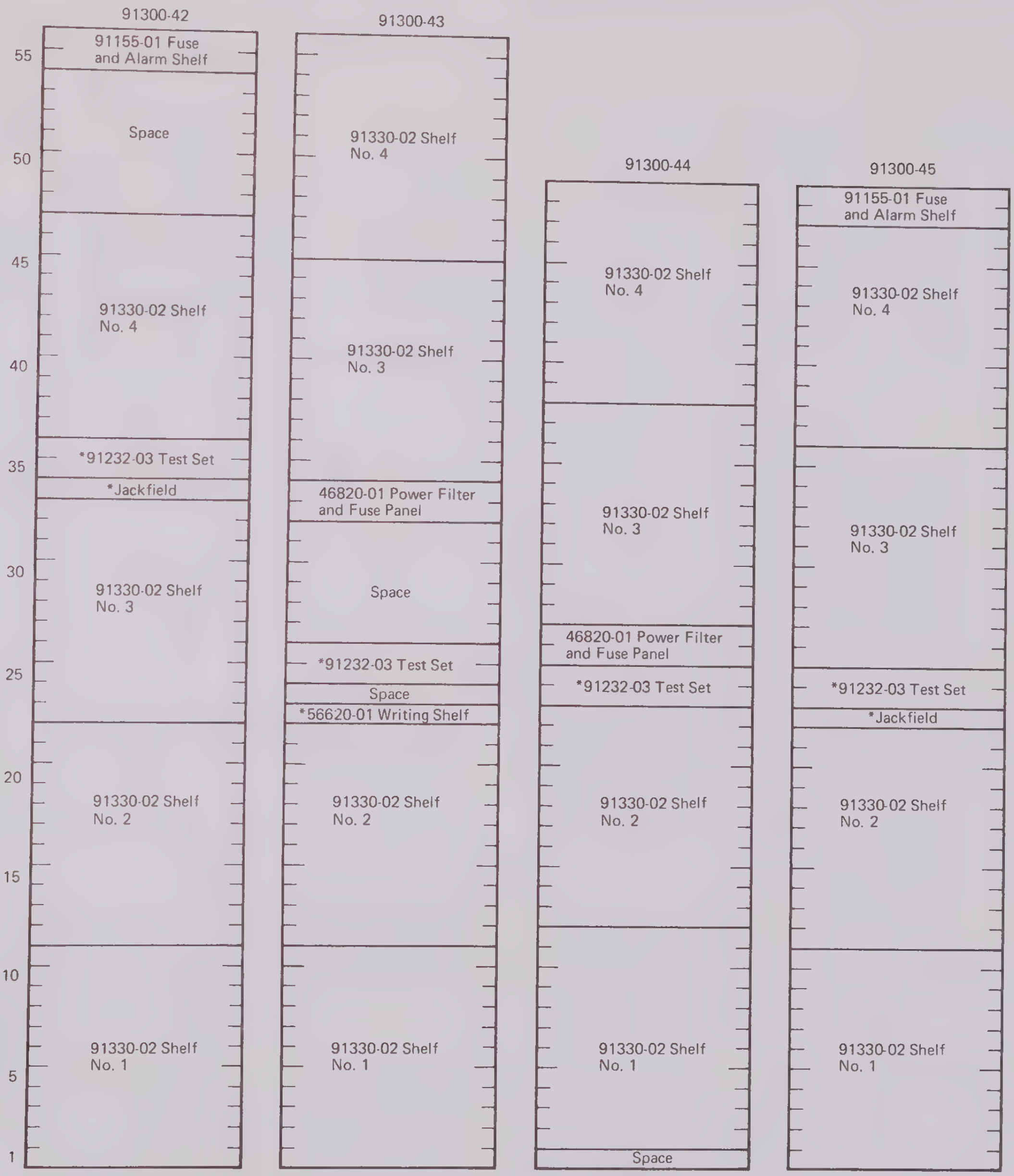
*Not included in standard assembly; order separately.

Figure 6-1. Standard Assemblies (Sheet 3 of 4)


91300-32
91330-02 Shelf No. 4
91330-02 Shelf No. 3
91330-02 Shelf No. 2
91330-02 Shelf No. 1
91300-33
91155-01 Fuse and Alarm Shelf
Space
*91232-03 Test Set
*Jackfield
91330-02 Shelf No. 3
91330-02 Shelf No. 2
91330-02 Shelf No. 1
91300-34
91330-02 Shelf No. 3
46820-01 Power Filter and Fuse Panel
Space
*91232-03 Test Set
*Jackfield
91330-02 Shelf No. 2
91330-02 Shelf No. 1
91300-41
Space
91155-01 Fuse and Alarm Shelf
Space
91330-02 Shelf No. 6
91330-02 Shelf No. 5
91330-02 Shelf No. 4
*91232-03 Test Set
*Jackfield
91330 02 Shelf No. 3
91330-02 Shelf No. 2
91330-02 Shelf No. 1
74
70
65
60
55
50
45
40
35
30
25
20
15
10
5
1

*Not included in standard assembly; order separately.

Figure 6-1. Standard Assemblies (Sheet 4 of 4)


91300-42
91155-01 Fuse and Alarm Shelf
Space
91330-02 Shelf No. 4
*91232-03 Test Set
*Jackfield
91330-02 Shelf No. 3
91330-02 Shelf No. 2
91330-02 Shelf No. 1
55
50
45
40
35
30
25
20
15
10
5
1
91300-43
91330-02 Shelf No. 4
91330-02 Shelf No. 3
46820-01 Power Filter and Fuse Panel
Space
*91232-03 Test Set
Space
*56620-01 Writing Shelf
91330-02 Shelf No. 2
91330-02 Shelf No. 1
91300-44
91330-02 Shelf No. 4
91330-02 Shelf No. 3
46820-01 Power Filter and Fuse Panel
*91232-03 Test Set
91330-02 Shelf No. 2
91330-02 Shelf No. 1
Space
91300-45
91155-01 Fuse and Alarm Shelf
91330-02 Shelf No. 4
91330-02 Shelf No. 3
*91232-03 Test Set
*Jackfield
91330-02 Shelf No. 2
91330-02 Shelf No. 1

*Not included in standard assembly; order separately.

Figure 6-2. Equipment Racks

Type No.	Height	Usable Mounting Spaces	Type No.	Height	Usable Mounting Spaces
Self-Supporting Channel Type (Aluminum)			Unequal-Flange Duct Type (Aluminum)		
31051-07	7'	44	31000-05	7'	43
-09	7' 6"	47	-04	8'	49
-10	8' 1/4"	51	-03	8' 8"	54
-21	8' 8"	54	-02	9'	56
-13	9'	57	-01	11' 6"	73
-14	9'	57	-06	11' 8"	74
-23	9' 6"	60			
Overhead-Supported Channel Type (Aluminum)					
31052-02	8'	49			
-05	9'	56			
-14	11' 6"	73			
-15	11' 8"	74			

Figure 6-3. Standard Rack Assemblies, Factory Wiring (Sheet 1 of 2)

Figure A. 46820 Power Filter and Fuse Panel

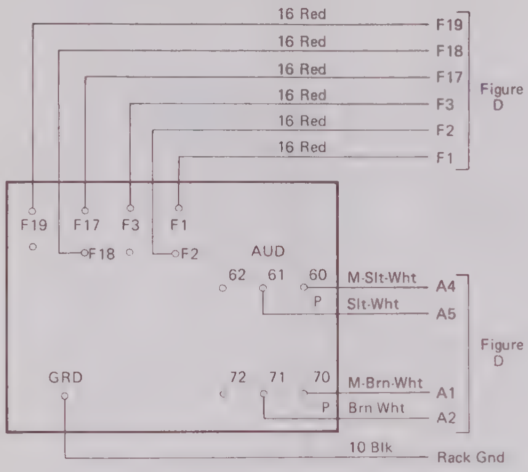

16 Red
F19
F18
F17
F3
F2
F1
Figure D
F19
F17
F3
F1
F18
F2
AUD
62
61
60
M-Slt-Wht
A4
P
Slt-Wht
A5
Figure D
GRD
72
71
70
M-Brn-Wht
A1
P
Brn Wht
A2
10 Blk
Rack Gnd

Figure B. 91155 Fuse and Alarm Shelf

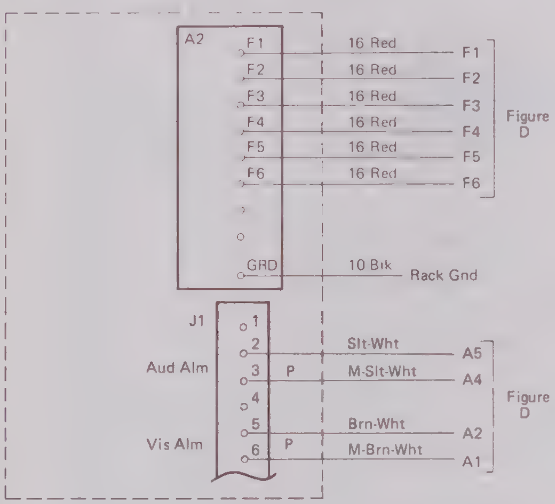

A2
F1
F2
F3
F4
F5
F6
16 Red
F1
F2
F3
F4
F5
F6
Figure D
GRD
10 Blk
Rack Gnd
J1
1
2
3
4
5
6
Aud Alm
Vis Alm
P
Slt-Wht
M-Slt-Wht
Brn-Wht
M-Brn-Wht
A5
A4
A2
A1
Figure D

Figure C. 91155 Fuse and Alarm Shelf (Note 1)

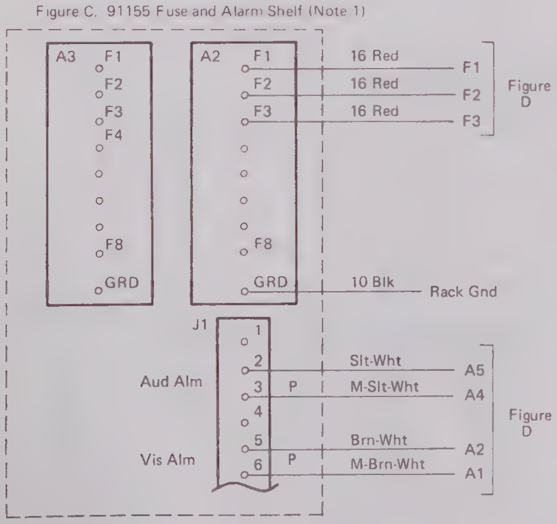

A3
F1
F2
F3
F4
F8
GRD
A2
F1
F2
F3
F8
GRD
16 Red
F1
F2
F3
Figure D
10 Blk
Rack Gnd
J1
1
2
3
4
5
6
Aud Alm
Vis Alm
P
Slt-Wht
M-Slt-Wht
Brn-Wht
M-Brn-Wht
A5
A4
A2
A1
Figure D

Figure D. 91330 Terminal Equipment Shelves

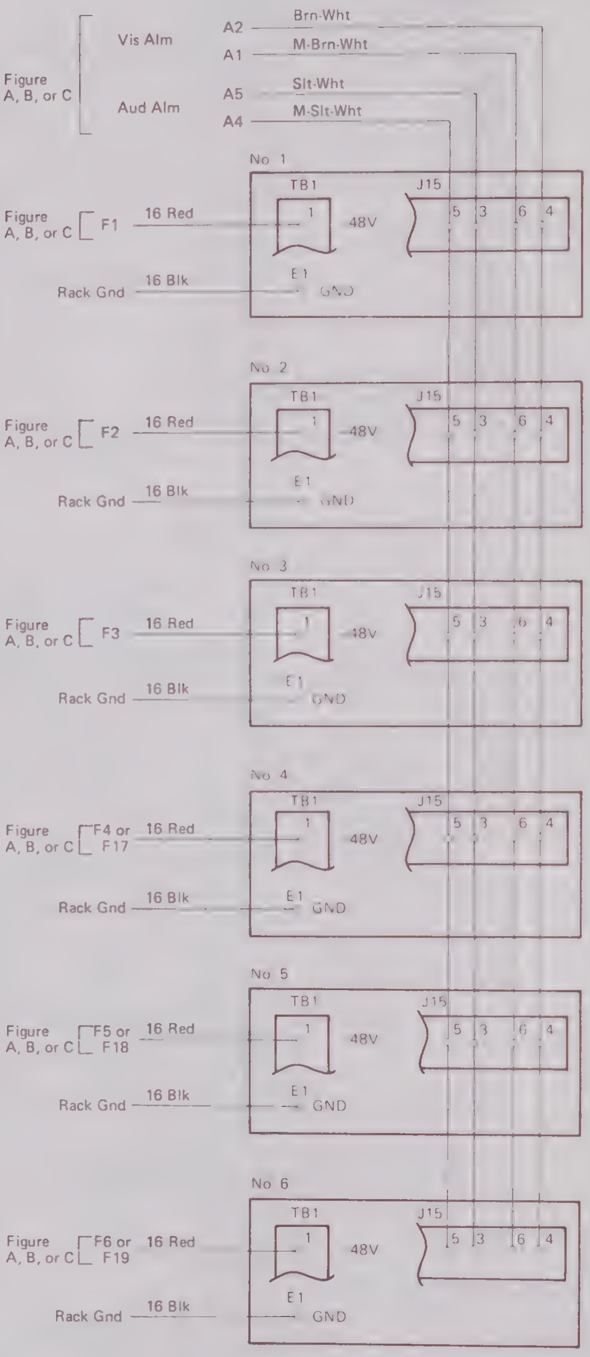
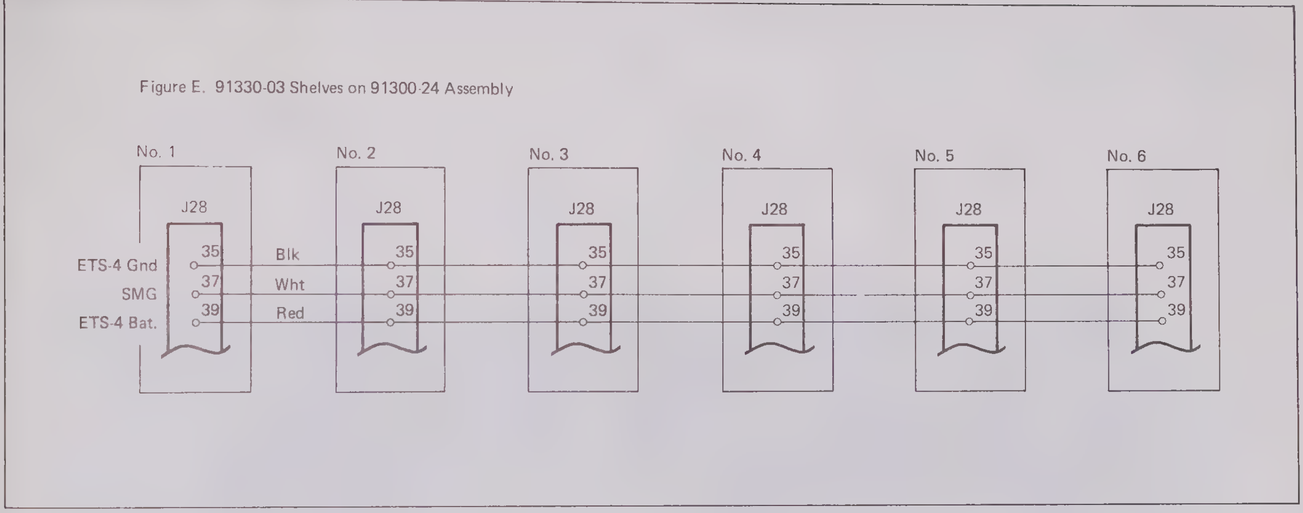


Figure A, B, or C
Vis Alm
Aud Alm
A2
A1
A5
A4
Brn-Wht
M-Brn-Wht
Slt-Wht
M-Slt-Wht
No 1
No 2
No 3
No 4
No 5
No 6
TB1
J15
1
48V
5
3
6
4
E1
GND
Figure A, B, or C
F1
F2
F3
F4 or F17
F5 or F18
F6 or F19
16 Red
Rack Gnd
16 Blk

NOTES:

1. Figure C pertains to the 91300-33 standard rack assembly. Fuse module A3 is provided for —48V distribution to an adjacent 91300-32 rack assembly.
2. Number preceding wire color is AWG. If unspecified, wire size is 22 AWG.
3. On later versions (after September 1978) of the 91300-21 and -24 rack assemblies, alarm leads A1, A2, A4, and A5 are not connected between figure D and figure A, B, or C. In figure D, the multiple connections between J15 on the 91330 shelves are shielded pairs, A1 and A2 in one pair and A4 and A5 in another. The shields are tied to rack ground.

Figure 6-3. Standard Rack Assemblies, Factory Wiring (Sheet 2 of 2)



(Continued from page 33.)

7. ORDERING INFORMATION

7.01 GTE Lenkurt equipment items listed in figures 5-1 through 5-4 and figure 6-1 may be ordered by specifying the identifying number and the name or a brief description.

7.02 Upon receiving the order, GTE Lenkurt will provide an acknowledgment and scheduled shipping date. An equipment list showing applicable assemblies and individual equipment items will be included in the shipment.

8. INSTALLATION

Receiving

8.01 When the equipment is received, inspect it carefully for damage. Claims for damage incurred in shipment should be made directly to the transportation company in accordance with their instructions. Save the shipping cartons until installation is completed.

Mounting

8.02 Figure 6-1 shows layouts of standard rack assemblies. These illustrations may be useful also in the rack layout of loose equipment. Refer to Part 4, Engineering Considerations, about locating the equipment in the office.

External Wiring to 91330 Shelf

8.03 Figure 8-1 illustrates the 91330 shelf and calls out the terminal boards and connectors at which external wiring is terminated in accordance with figures 8-2 and 8-3.

8.04 Power and Alarm. As shown in figure 8-2, connect external power to terminal board TB1 (screw terminals) and office alarm circuits to receptacle connector J15 (wirewrap terminals). Refer to paragraphs 4.11 and 4.12 for information on wire sizes.

8.05 Transmit Clock. Strap terminal board TB2 (screw terminals) for the applicable transmit clock option in accordance with figure 3-1.

8.06 DS1 Cables. Wire the DS1 transmit and receive shielded cables to J15 as shown in figure 8-2. See paragraphs 4.35 through 4.38 for engineering considerations on cable installation, types of cable, and maximum lengths.

8.07 If the 91330 shelf is to be used for storing spare units in an operating condition, loop the DS1 signal by connecting jumpers on J15 between pins 7 and 8 and between pins 9 and 10.

8.08 Drop Wiring. Figures 8-3A through 8-3D show the four or five pairs that comprise the external vf and signaling/supervisory circuits of one channel unit. Not all circuits are required by every type of channel unit. If the shelf is 91330-01 or -02, you will need to refer to the applicable GTEP Section listed in figure 1-2 to determine which circuits in figure 8-3A or 8-3B are required. Figures 8-3C and 8-3D are particularly for 91251 ETS-4 Channel Units and 91238 No. 2 EAX Channel Units, respectively; refer to GTEP Section 342-911-149 (91251) or 342-911-142 (91238).

8.09 Figure 8-3 shows factory-installed TMB (trunk-make-busy) strapping on the channel unit receptacle connectors. When a channel unit is unplugged, switching contacts 31-32 and 33-34 close. Strapping changes may be required for some channel units; this information is given in the individual channel unit GTEP Sections.

8.10 On the 91330-01 shelf, the vf and signaling/supervisory circuits connect to wirewrap terminals on connectors J1-J12 and J17-J28. Run wires across the shelf above the channel unit connectors and secure with the cable ties furnished. Continue wires down alongside the connectors and fan out to the applicable wirewrap terminal, leaving a small slack loop. Dress wires so that they don't interfere with installation of plastic covers.

8.11 On the 91330-02, -03, or -04 shelf, the vf and signaling/supervisory circuits enter through Cable Assemblies 163-10315-xx or 163-10316-xx, which plug into 50-pin shelf connectors J30 through J34; figure 8-3E shows typical external wiring to one pin-pair on 24 channel units. For applications with the 5215B Miniature Jackfield Assembly, see figure 8-4.

Power Distribution Equipment

8.12 Power distribution and alarm circuits on the standard rack assemblies are factory-wired as shown in figure 6-3. This figure may also be used as a guide in field wiring an installation of loose equipment. Refer to figures 3-13 and 3-14 for external connections and strapping of the 46820 panel and the 91155 shelf, respectively.

(Text continues on page 47.)

Figure 8-1. 91330 Shelf, Front and Rear Views (Sheet 1 of 3)

Figure A. 91330 Shelf, Front View

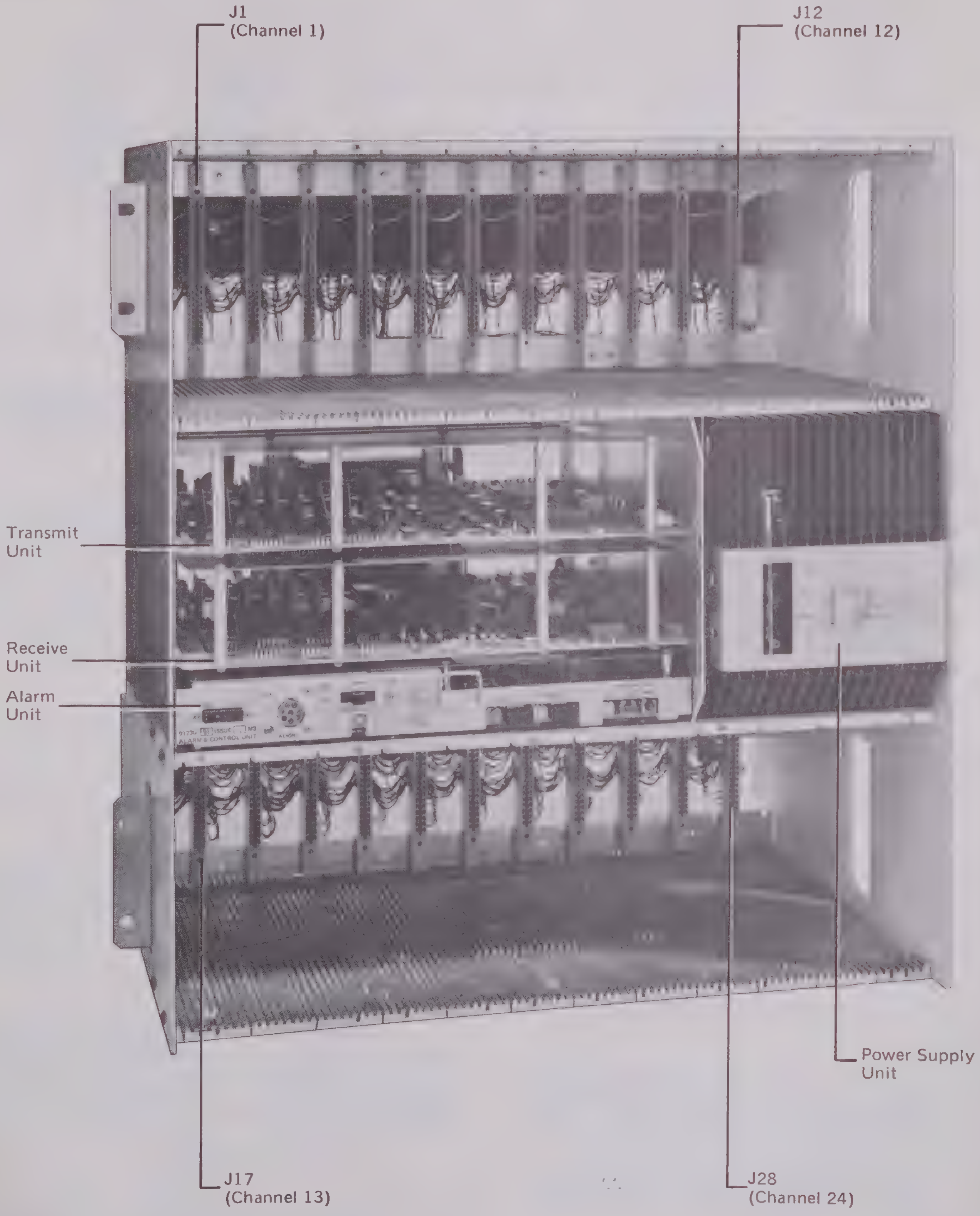
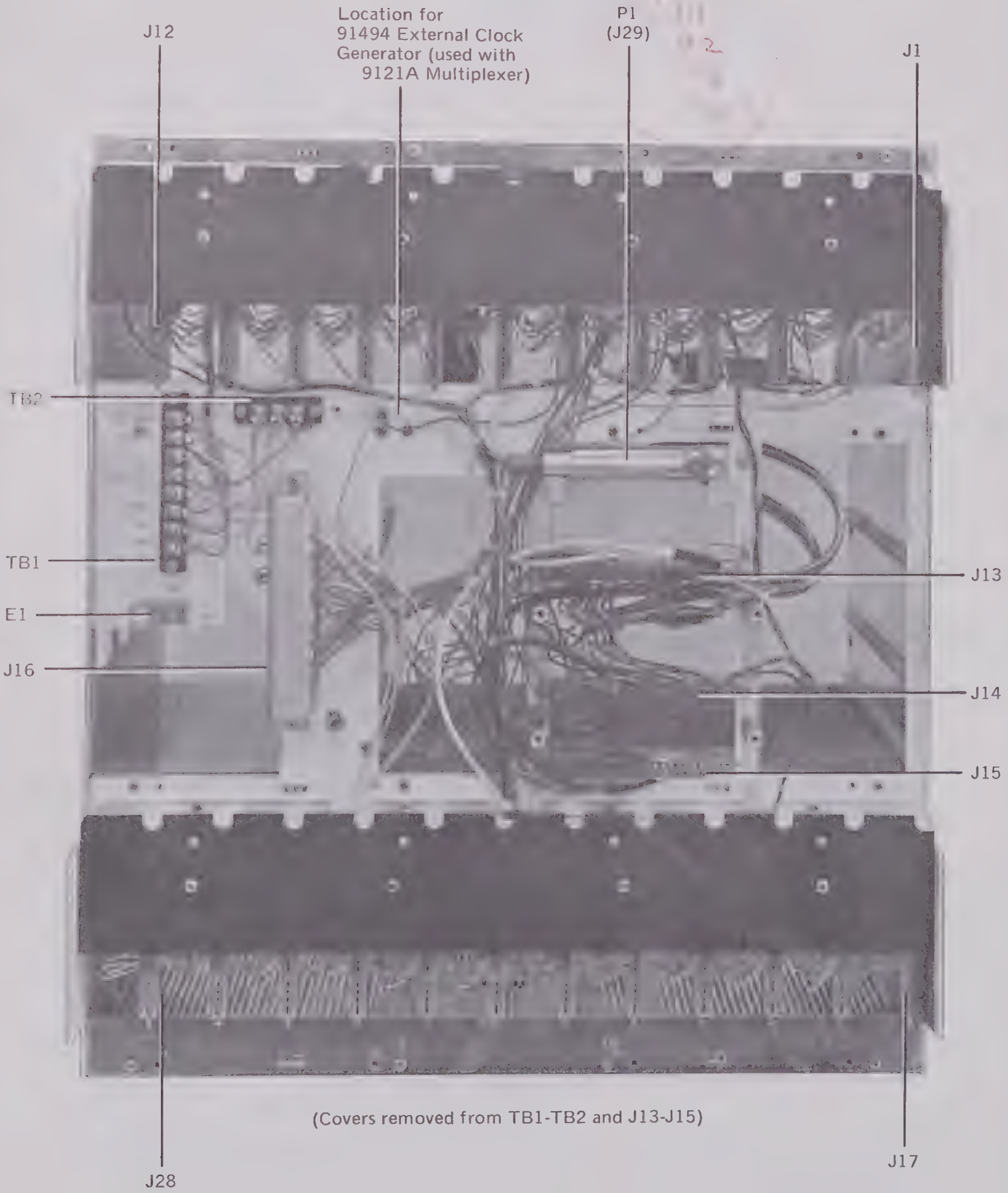

J1
(Channel 1)
J12
(Channel 12)
Transmit Unit
Receive Unit
Alarm Unit
Power Supply Unit
J17
(Channel 13)
J28
(Channel 24)

Figure 8-1. 91330 Shelf, Front and Rear Views (Sheet 2 of 3)

Figure B. 91330-01 Shelf, Rear View


J12
Location for 91494 External Clock Generator (used with 9121A Multiplexer)
P1 (J29)
J1
TB2
TB1
E1
J16
J13
J14
J15
J28
J17

(Covers removed from TB1-TB2 and J13-J15)

Figure 8-1. 91330 Shelf, Front and Rear Views (Sheet 3 of 3)

Figure C. 91330-02, -03, or -04 Shelf, Rear View

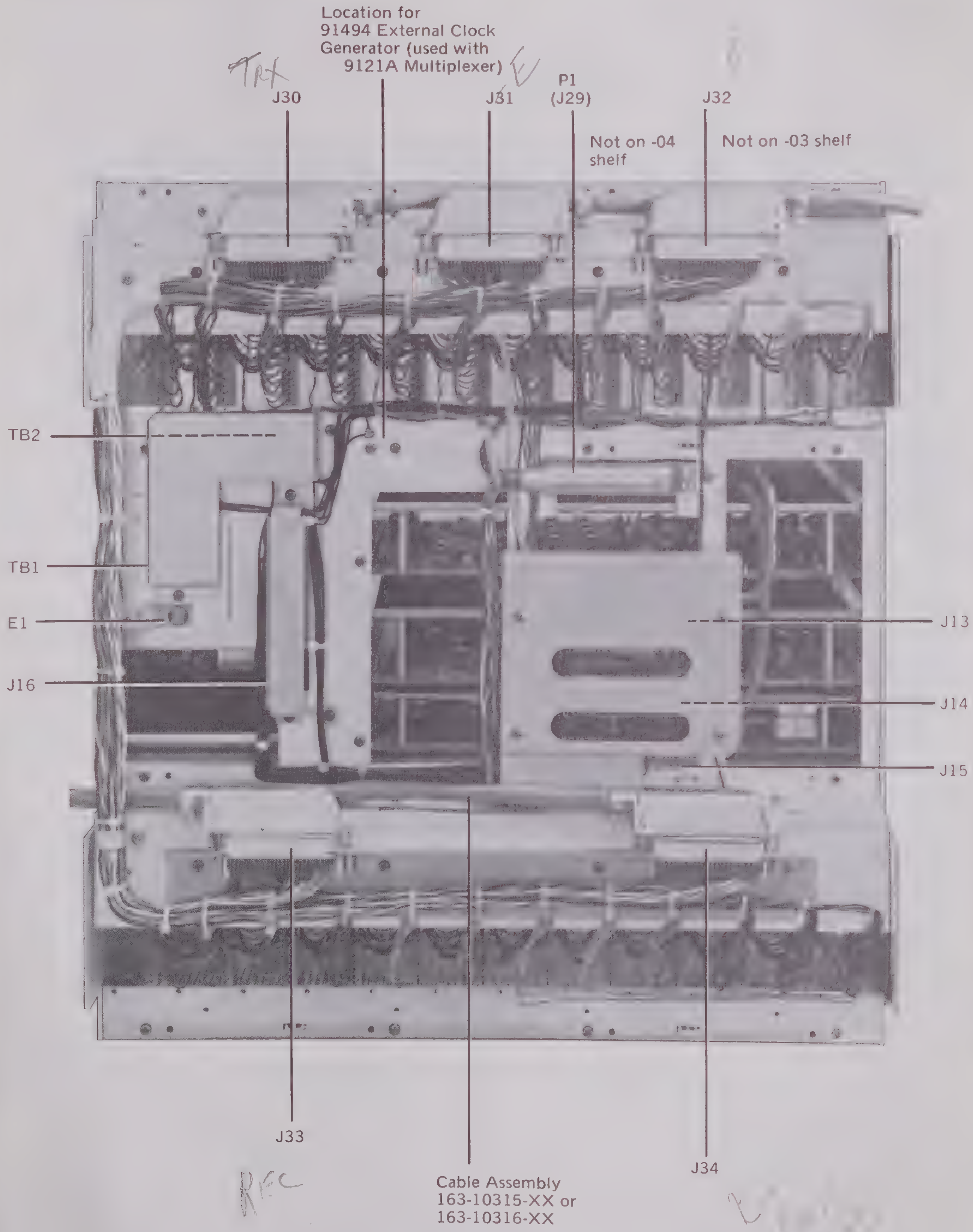

Location for
91494 External Clock
Generator (used with
9121A Multiplexer)
TRX
E
J30
J31
P1
(J29)
J32
Not on -04 shelf
Not on -03 shelf
TB2
TB1
E1
J16
J13
J14
J15
J33
J34
REC
Cable Assembly
163-10315-XX or
163-10316-XX

Figure 8-2. Power, Alarm, and DS1 Wiring to 91330 Shelf

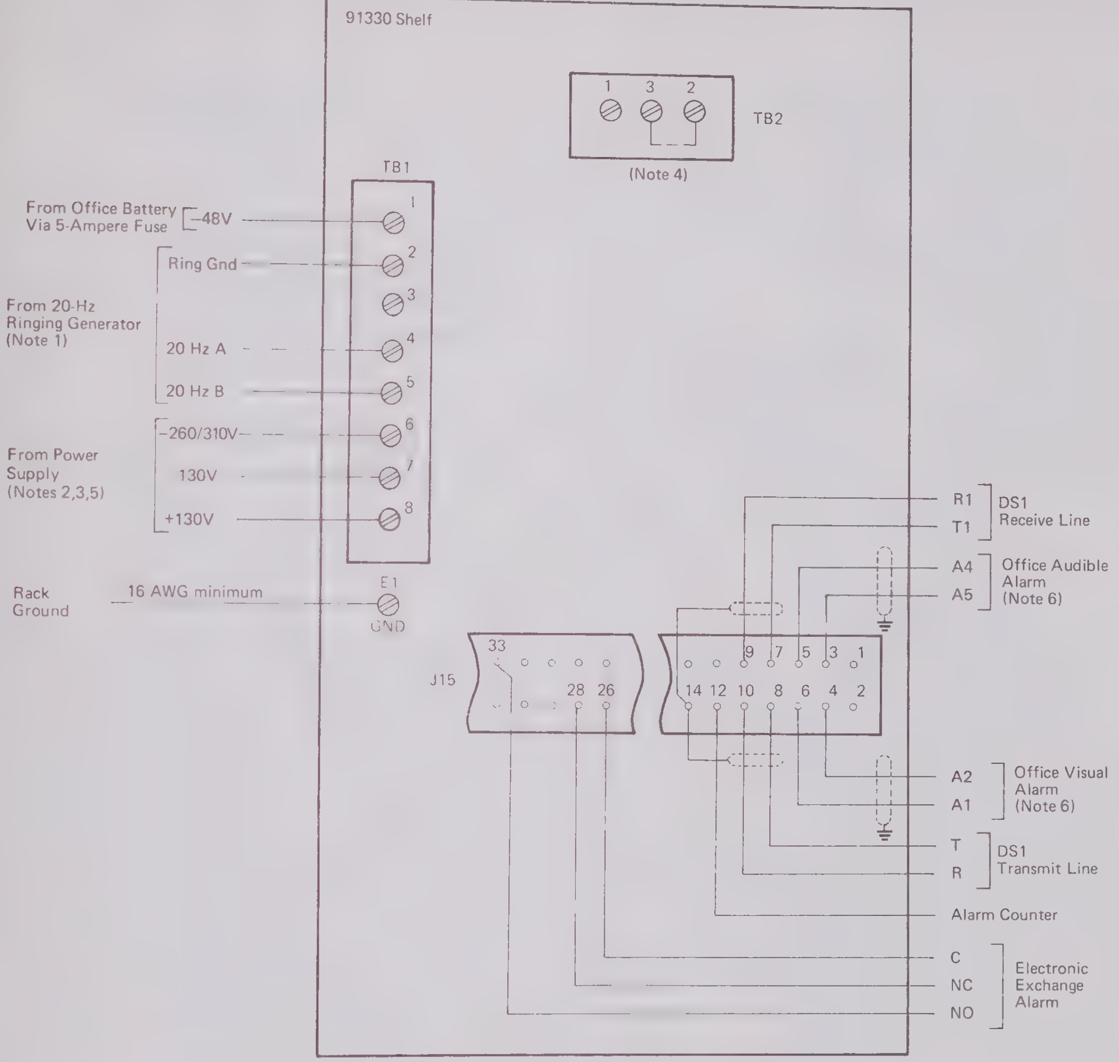
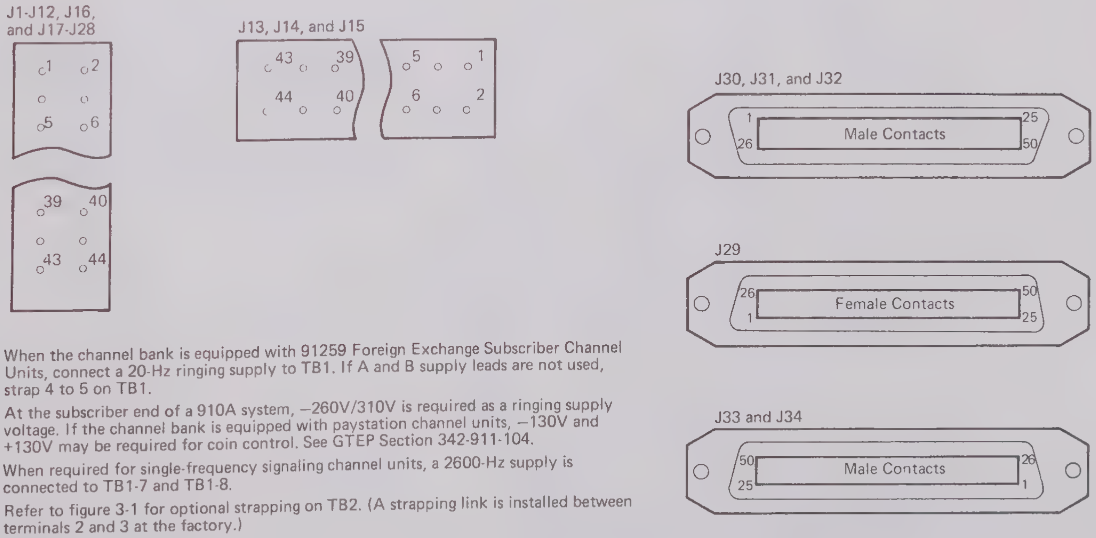

91330 Shelf
1
3
2
TB2
(Note 4)
TB1
From Office Battery Via 5-Ampere Fuse
−48V
1
Ring Gnd
2
3
From 20-Hz Ringing Generator (Note 1)
20 Hz A
4
20 Hz B
5
From Power Supply (Notes 2,3,5)
−260/310V
6
130V
7
+130V
8
Rack Ground
16 AWG minimum
E1
GND
R1
T1
DS1 Receive Line
A4
A5
Office Audible Alarm (Note 6)
33
J15
28
26
9
7
5
3
1
14
12
10
8
6
4
2
A2
A1
Office Visual Alarm (Note 6)
T
R
DS1 Transmit Line
Alarm Counter
C
NC
NO
Electronic Exchange Alarm

Figure A. Connector Contact Numbering (Viewed From Rear of Shelf)


J1-J12, J16, and J17-J28
1
2
5
6
39
40
43
44
J13, J14, and J15
43
39
44
40
5
1
6
2
J30, J31, and J32
1
25
26
50
Male Contacts
J29
26
50
1
25
Female Contacts
J33 and J34
50
26
25
1
Male Contacts

NOTES:
1. When the channel bank is equipped with 91259 Foreign Exchange Subscriber Channel Units, connect a 20-Hz ringing supply to TB1. If A and B supply leads are not used, strap 4 to 5 on TB1.
2. At the subscriber end of a 910A system, −260V/310V is required as a ringing supply voltage. If the channel bank is equipped with paystation channel units, −130V and +130V may be required for coin control. See GTEP Section 342-911-104.
3. When required for single-frequency signaling channel units, a 2600-Hz supply is connected to TB1-7 and TB1-8.
4. Refer to figure 3-1 for optional strapping on TB2. (A strapping link is installed between terminals 2 and 3 at the factory.)
5. On the 91330-04 shelf, TB1-6 and TB1-8 are not used; TB1-7 is assigned to ringback tone (RBT) from external equipment
6. Shielded pairs are recommended for office alarm wiring.

Figure 8-3. Drop Wiring to 91330 Shelf (Sheet 1 of 2)

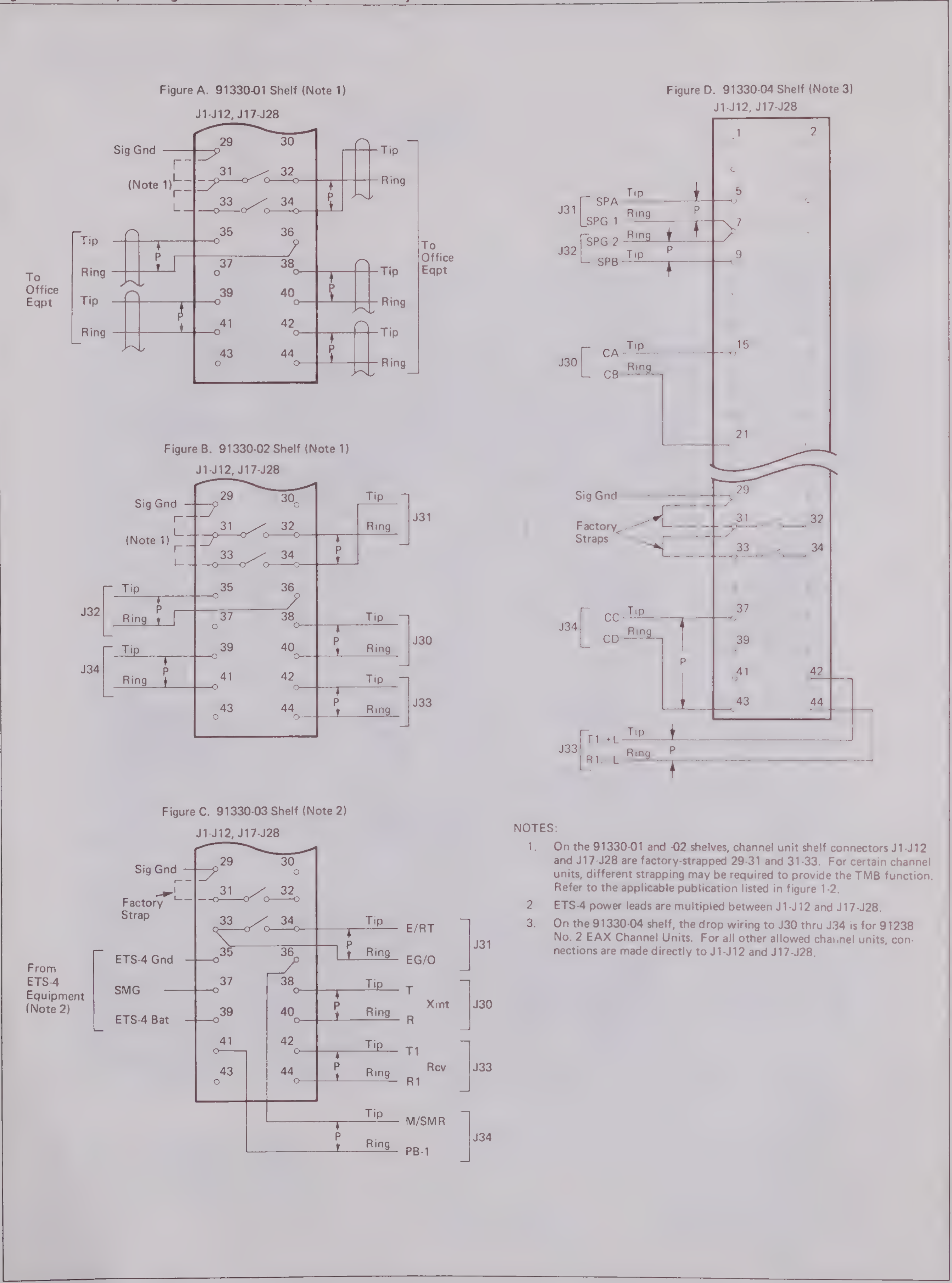


Figure A. 91330-01 Shelf (Note 1)

Figure B. 91330-02 Shelf (Note 1)

Figure C. 91330-03 Shelf (Note 2)

Figure D. 91330-04 Shelf (Note 3)

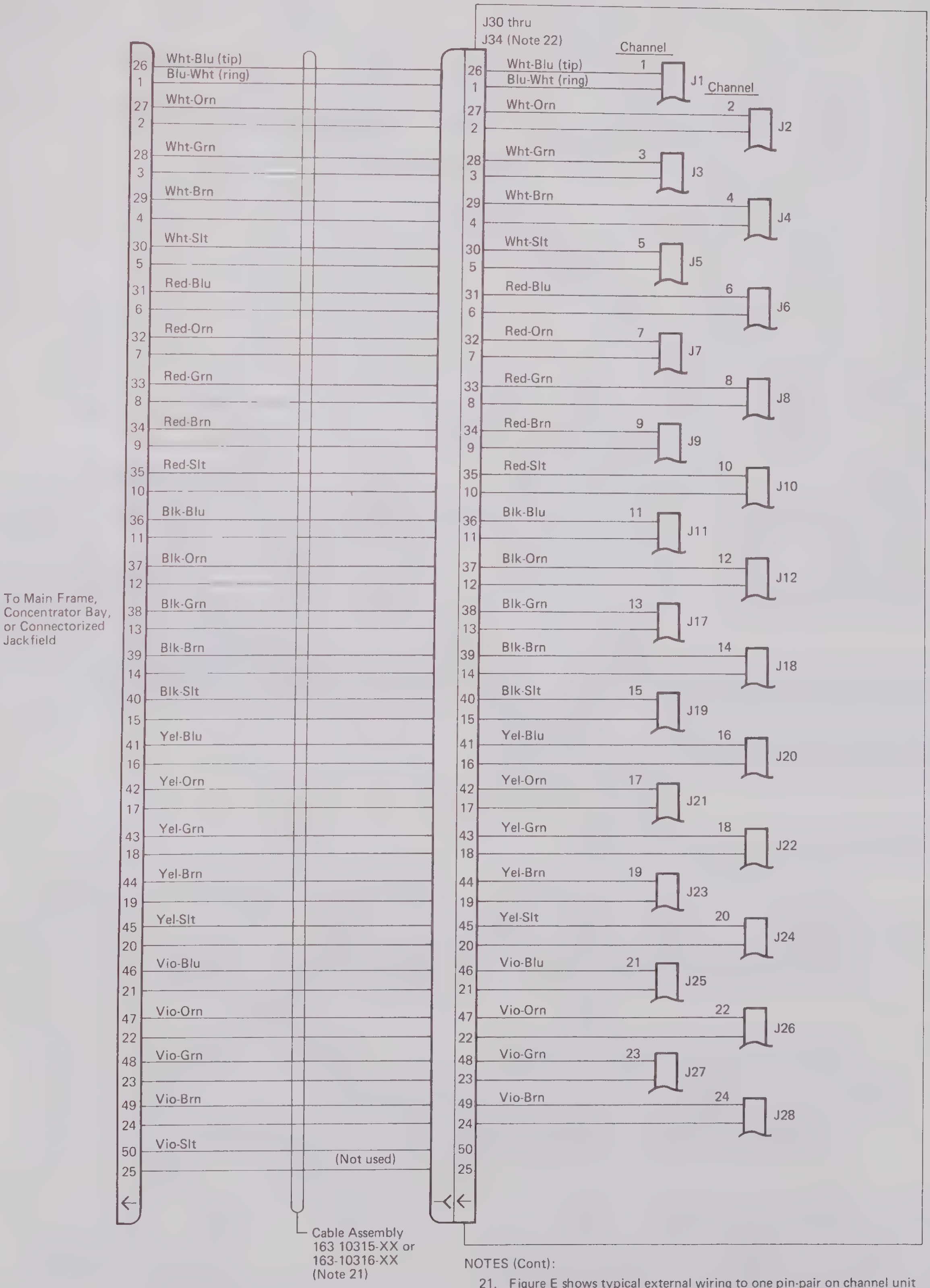
J1-J12, J17-J28
Sig Gnd
(Note 1)
Factory Strap
Factory Straps
Tip
Ring
P
To Office Eqpt
From ETS-4 Equipment (Note 2)
ETS-4 Gnd
SMG
ETS-4 Bat
E/RT
EG/O
T
R
Xmt
T1
R1
Rcv
M/SMR
PB-1
J30
J31
J32
J33
J34
SPA
SPG 1
SPG 2
SPB
CA
CB
CC
CD
T1 +L
R1 L
1
2
5
7
9
15
21
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44

NOTES:

1. On the 91330-01 and -02 shelves, channel unit shelf connectors J1-J12 and J17-J28 are factory-strapped 29-31 and 31-33. For certain channel units, different strapping may be required to provide the TMB function. Refer to the applicable publication listed in figure 1-2.
2. ETS-4 power leads are multipled between J1-J12 and J17-J28.
3. On the 91330-04 shelf, the drop wiring to J30 thru J34 is for 91238 No. 2 EAX Channel Units. For all other allowed channel units, connections are made directly to J1-J12 and J17-J28.

Figure 8-3. Drop Wiring to 91330 Shelf (Sheet 2 of 2)

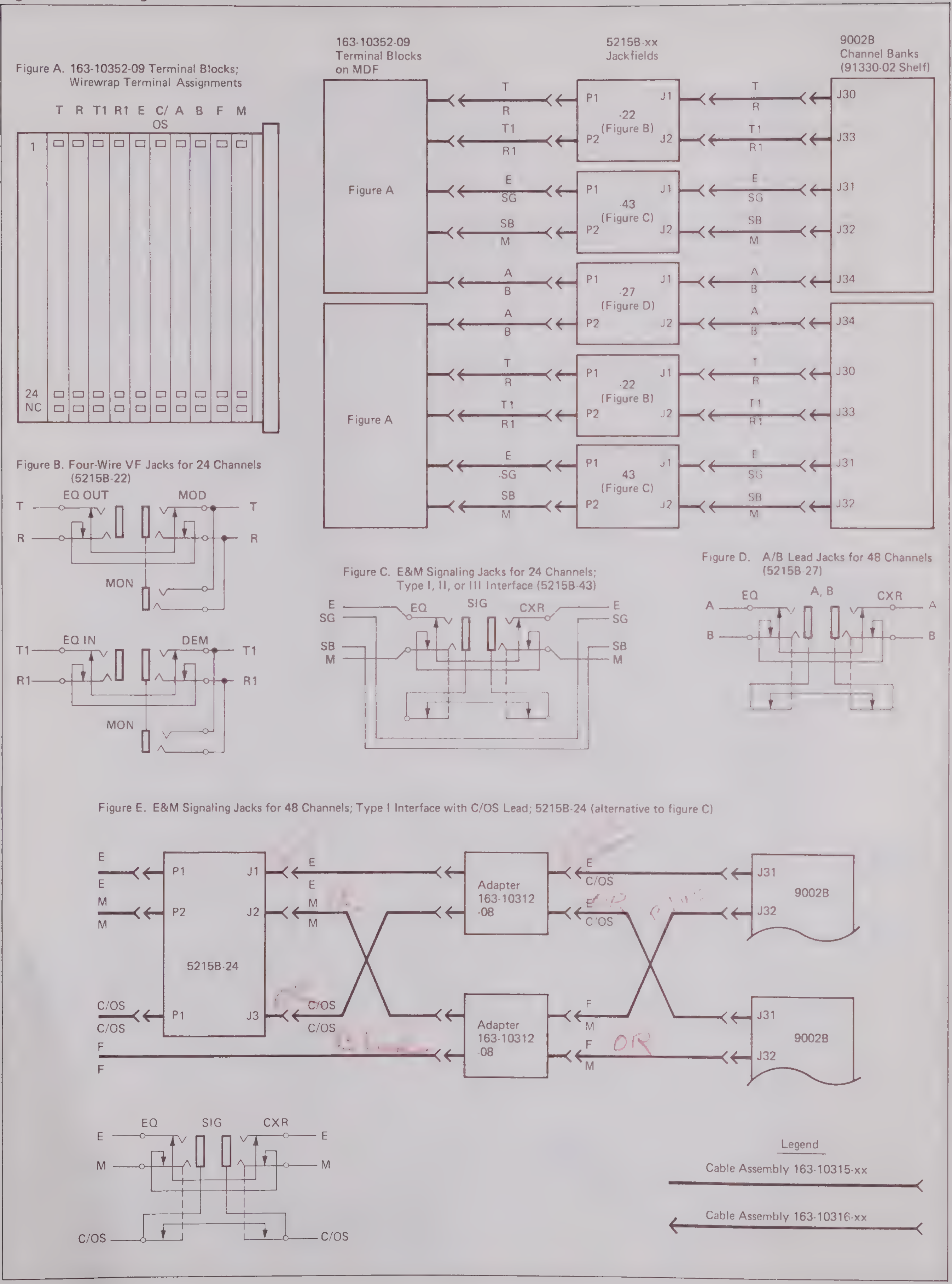
Figure E. Drop Wiring to 91330-02, -03, or -04 Shelf


91330-02, -03, or -04 Shelf
J30 thru J34 (Note 22)
Channel
To Main Frame, Concentrator Bay, or Connectorized Jackfield
Wht-Blu (tip)
Blu-Wht (ring)
Wht-Orn
Wht-Grn
Wht-Brn
Wht-Slt
Red-Blu
Red-Orn
Red-Grn
Red-Brn
Red-Slt
Blk-Blu
Blk-Orn
Blk-Grn
Blk-Brn
Blk-Slt
Yel-Blu
Yel-Orn
Yel-Grn
Yel-Brn
Yel-Slt
Vio-Blu
Vio-Orn
Vio-Grn
Vio-Brn
Vio-Slt
(Not used)
26 1 27 2 28 3 29 4 30 5 31 6 32 7 33 8 34 9 35 10 36 11 37 12 38 13 39 14 40 15 41 16 42 17 43 18 44 19 45 20 46 21 47 22 48 23 49 24 50 25
1 J1
2 J2
3 J3
4 J4
5 J5
6 J6
7 J7
8 J8
9 J9
10 J10
11 J11
12 J12
13 J17
14 J18
15 J19
16 J20
17 J21
18 J22
19 J23
20 J24
21 J25
22 J26
23 J27
24 J28
Cable Assembly 163 10315-XX or 163-10316-XX (Note 21)

NOTES (Cont):

21. Figure E shows typical external wiring to one pin-pair on channel unit shelf connectors J1-J12 and J17-J28. At the drop end of the cable assemblies, 163-10315-XX is unterminated and 163-10316-XX is terminated in a male connector as shown.
22. Receptacle connector J32 is not used on the 91330-03 shelf.

Figure 8-4. Cabling From 9002B Channel Bank to 5215B Jackfield and MDF


163-10352-09 Terminal Blocks on MDF
5215B-xx Jackfields
9002B Channel Banks (91330-02 Shelf)
Figure A. 163-10352-09 Terminal Blocks; Wirewrap Terminal Assignments
T R T1 R1 E C/OS A B F M
1
24
NC
Figure A
T
R
T1
R1
E
SG
SB
M
A
B
P1
J1
P2
J2
-22 (Figure B)
-43 (Figure C)
-27 (Figure D)
43 (Figure C)
J30
J33
J31
J32
J34
Figure B. Four-Wire VF Jacks for 24 Channels (5215B-22)
EQ OUT
MOD
MON
EQ IN
DEM
Figure C. E&M Signaling Jacks for 24 Channels; Type I, II, or III Interface (5215B-43)
EQ
SIG
CXR
Figure D. A/B Lead Jacks for 48 Channels (5215B-27)
A, B
Figure E. E&M Signaling Jacks for 48 Channels; Type I Interface with C/OS Lead; 5215B-24 (alternative to figure C)
5215B-24
J3
C/OS
F
Adapter 163-10312 -08
9002B
OR
Legend
Cable Assembly 163-10315-xx
Cable Assembly 163-10316-xx

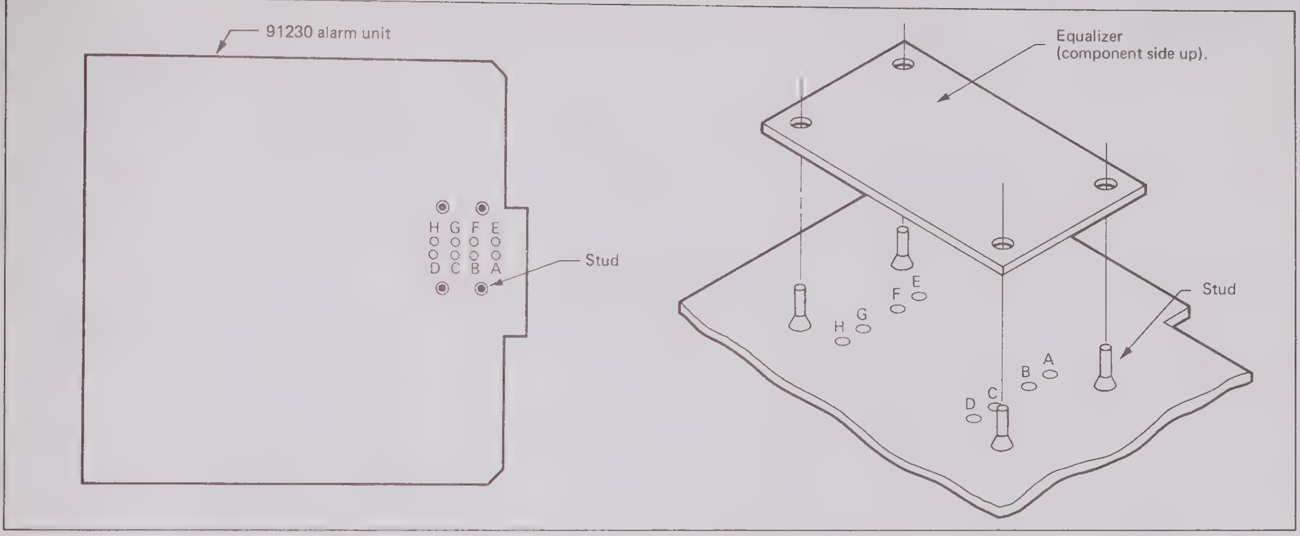


Figure 8-5. Cable Equalizer Installation

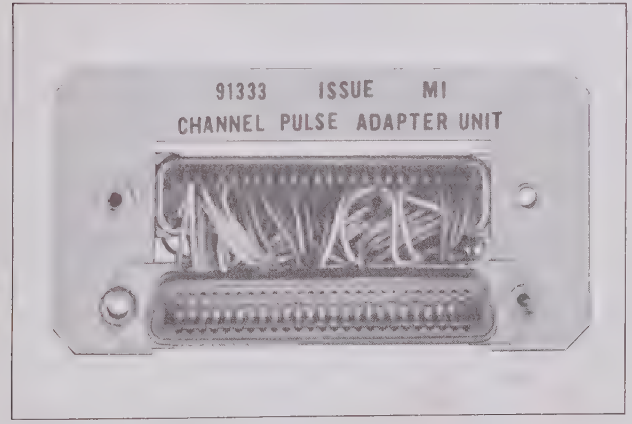


Figure 8-6. 91333 Channel Pulse Adapter Unit

(Continued from page 39.)

Common Equipment Unit Strapping

8.13 Install or verify the optional strapping on the common equipment units as described below. See the referenced figure (circuit diagram) for strapping details. Units then may be plugged into their shelf mounting positions (figure 8-1).

CAUTION: Shelf connectors for the 91221, 91222, and 91230 units are keyed. Trying to force a unit into the wrong mounting position will damage the equipment.

(a) Transmit unit (figure 3-4): strap for transmit clock source and signaling option.

(b) Receive unit (figure 3-7): strap for channel unit signaling condition (on-hook or off-hook) during frame search or remote alarm.

(c) Power supply unit: no optional strapping.

(d) Alarm unit (figure 3-8): strap for office alarms and for alarm sequence. Refer to the next paragraph before you plug in the alarm unit.

DS1 Cable Equalizer

8.14 The DS1 transmit signal path of the channel bank goes through a 6-dB pad on the 91230 alarm unit. If applicable in accordance with figure 4-1, install Cable Equalizer 087-53258-02 or 087-53259-02 on the 91230 alarm unit in accordance with figure 8-5 and the following:

(a) Disconnect 6-dB pad by cutting straps A-B, C-D, E-F, and G-H on 91230 alarm unit.

(b) With equalizer in either orientation and component side up, mate four eyelet terminals on equalizer with four studs on 91230 alarm unit.

(c) Solder terminals to studs.

8.15 Plug the 91230 alarm unit into the lower horizontal mounting position of the 91330 shelf.

Channel Pulse Adapter

8.16 In the D3 configuration of the channel bank, channel pulses generated in the transmit unit and receive unit are distributed to the channel units through shelf wiring and mating connectors P1 and J29 (figure 8-1). For the D1D or D2 configurations, verify that a 91333 Channel Pulse Adapter Unit (figure 8-6) is installed between P1 and J29: 91333-01 for D1D; 91333-02 for D2.

8.17 If installation of a 91333 adapter unit in the channel bank is required, proceed as follows:

(a) Remove power from channel bank.

(b) Unplug and remove transmit unit.

(c) Remove two 4-40 machine screws attaching P1 to J29. The screws face opposite directions; remove one from the front of the shelf and one from the rear.

(d) Plug P1 into 91333 adapter unit and fasten them together with front and rear screws.

(e) Plug 91333 adapter unit into J29 and secure with front and rear screws.

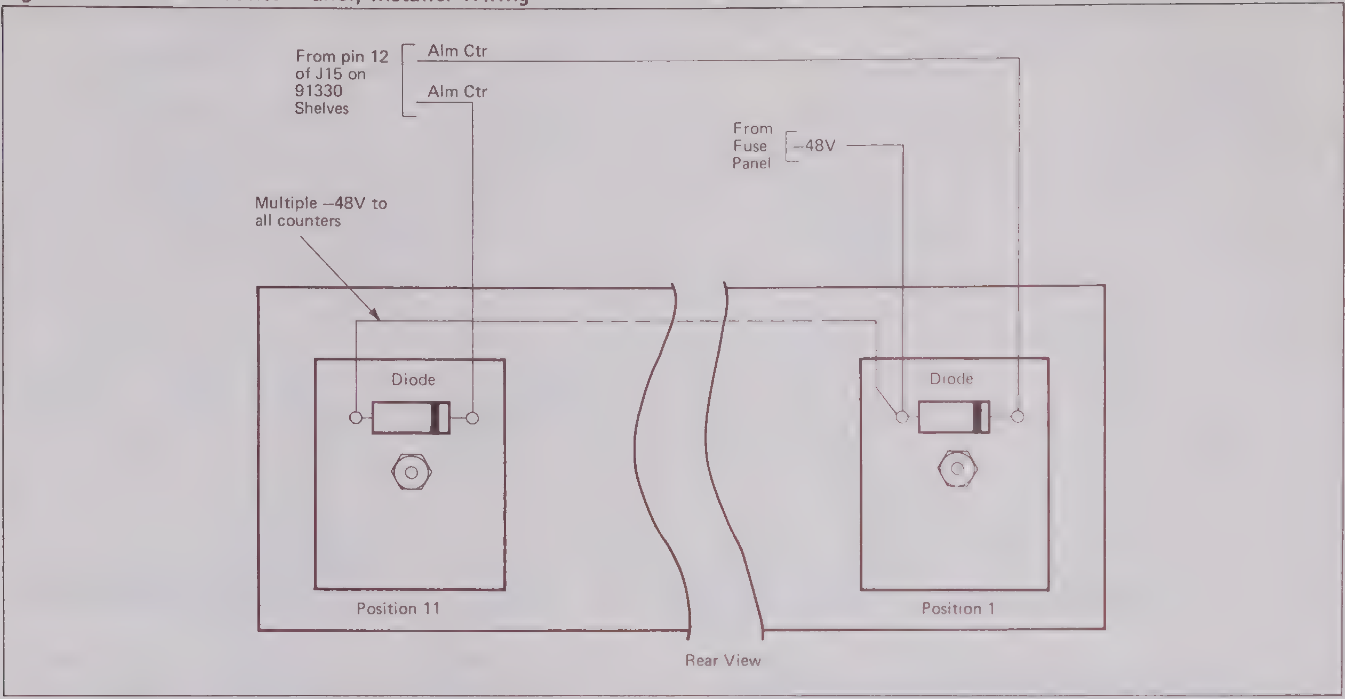
(f) Plug transmit unit into shelf.

(g) Reapply power to channel bank.

Channel Unit Strapping

8.18 Strap the channel units for the required options as specified in the applicable GTEP Section in figure 1-2. Also, most channel units have strappable or switch-selectable pads that must be set to coordinate vf drop levels with the office equipment. In setting the pads on two-wire channel units, allow for the hybrid transformer loss, which may be 3.5, 4, or 5 dB. Don't install the channel units until the end of the preliminary checkout procedure in the next paragraph.

Figure 8-7. 91065 Counter Panel, Installer Wiring



Preliminary Checkout

8.19 Alignment of the channel bank is covered in Section 342-911-109. First, however, the following loopback test will partially verify common equipment operation. The 91232 test set is used to force the channel bank into a loopback mode.

(a) Apply —48V dc power to the channel bank by installing a 5-ampere fuse in the power distribution equipment.

(b) Release LOOP button on 91230 alarm unit.

(c) Connect Alignment Cord 032-91232-01 between ALIGN connectors on test set and 91230 alarm unit.

(d) On the test set:

(1) POWER ON indicator should be lighted. (The model 1 test set has an integral POWER pushbutton and indicator; if the indicator is dark, momentarily depress the pushbutton.)

(2) Release PUSH TO TEST TERMINAL button.

(3) Set DIGITAL FUNCTION switch to any position on LOOP side of switch.

(4) Momentarily depress PUSH TO LOOP TERMINAL button.

(e) Indicators on the 91230 alarm unit should be as follows:
Lighted: ACO, LOOP, and SYSTEM ALARM
Dark: PWR, REM, and LOC.

(f) If SWITCH ALERT indicator on 91230 unit is lighted, set slide-switch S3 to NORM (center) position.

(g) If indicators on the 91230 alarm unit are not as described above, refer to the troubleshooting procedures in GTEP Section 342-911-109.

(h) When trouble has been cleared, install the channel units in the shelf.

91065 Counter Panel

8.20 Electromechanical counter modules are installed from the front of the panel and retained by a spring clip. Refer to figure 8-7 for wiring.

9. ALIGNMENT

9.01 Refer to GTEP Section 342-911-109 for alignment of the 9002B channel bank. During alignment, slide-switch S3 on the 91230 alarm unit must be in NORM (center) position. (The SWITCH ALERT indicator lights when S3 is not in NORM position.)

10. MAINTENANCE

10.01 Refer to GTEP Section 342-911-109 for maintenance information, including troubleshooting and factory service.

GTE LENKURT

Company Headquarters and
Manufacturing Facility

1105 County Road
San Carlos, California 94070
Phone 415—595-3000

Albuquerque
Manufacturing Facility

One Camino de Lenkurt
Albuquerque, New Mexico 87123
Phone 505—296-0551

El Paso
Manufacturing Facility

10727 Gateway West
El Paso, Texas 79935
Phone 915—593-3400

District
Sales Offices

1105 County Road
San Carlos, California 94070
Phone 415—595-3000

120 West Eastman Street
Arlington Heights, Illinois 60004
Phone 312—398-6700

542 Haggard Street, Suite 510
Plano, Texas 75074
Phone 214—422-4305

7950 Woodruff Court
Springfield, Virginia 22151
Phone 703—321-8560

361 E. Paces Ferry Rd., N.E.
Atlanta, Georgia 30305
Phone 404—261-8282

GTE International
Sales Office

1105 County Road
San Carlos, California 94070
Phone 415—595-3000
Cable: GENTELINT

9002A/B PCM Carrier Channel Units

APPLICATIONS

- Intertoll, toll-connecting, foreign exchange, special services and extended area service.

COMMON FEATURES

- Level coordination attenuators for office loss compensation and VNL buildout.
- Trunk processing (TMB) during system alarm.
- Busy indicator lamps and switches.
- Maintenance jacks.

SPECIAL FEATURES

E&M Channel Units

- Type I, II, and III interfaces as well as battery, ground, or open signals.
- Auxiliary supervisory leads (C, OS, B1/B2) for TMB.
- Two-wire terminations at 600 or 900 ohms, four-wire terminations at 600 ohms.

Loop Channel Units

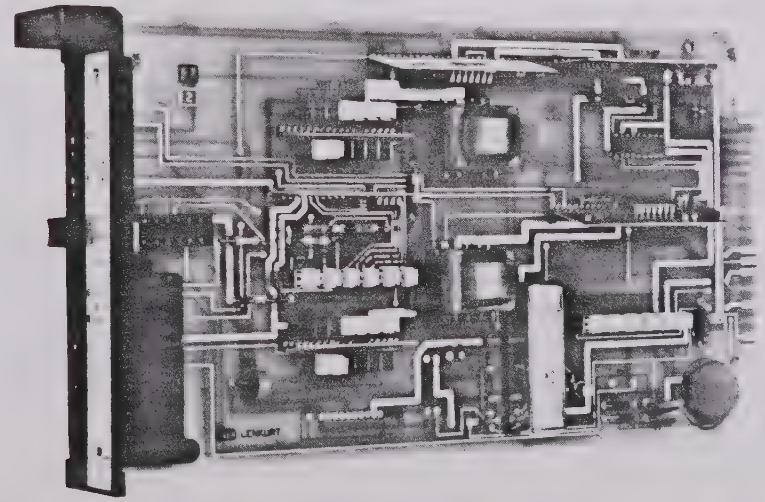
- DPO with calling party forced release (CPFR).
- DPO with non-reverse battery vf port strap option.
- DPT available with optional pulse correction.
- DPT with integrity check and resistive pulsing.
- Both DPO and DPT offer delay dial and wink start supervision.

Foreign Exchange Units

- Gain transfer capability.
- Ground-start or loop-start strappable option.
- Pulse correction.

Special Application Units

- Tandem trunks for special services including FX and pulse link repeating.
- SF signaling for fdm to pcm tandem trunks.
- No. 2 EAX interface direct to switch (replaces No. 2 EAX trunks for pcm transmission).
- Physical loop trunks to digital switches and DX to pcm tandem trunks with no auxiliary trunk requirements.



Typical 9002A/B
Channel Unit

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GENERAL

1.01 This Section provides basic information about channel units used in the 9002A and 9002B PCM Channel Banks for intertoll, toll-connecting, and exchange applications. It includes functional descriptions, applications, and ordering information. GTEP Sections for individual channel unit types are listed in figure 1-1. The channel banks are documented in Sections 342-911-103 (9002A) and 342-911-107 (9002B). Subscriber and pay-station channel units, which are part of the 910A system, are included in Section 342-911-104.

1.02 This Section is reissued to incorporate Addendum 1 to GTEP issue 2. The Addendum added the -03 and -04 options of the 91254 Model 2 channel unit. The -03 option has since been placed on A&M status.

1.03 The following information is added in this revision.

(a) The -01 and -04 options of the 91252 Model 1 channel unit are added to the list of available channel units.

(b) Applications data is added on interface of 91243, 91245, 91253, and 91255 channel units.

1.04 Marginal arrows indicate significant changes. Remove Issue 2 of this Section and Addendum 1 to Issue 2 and replace them with this Issue.

2. BASIC CHANNEL UNIT

2.01 The basic vf transmit and receive paths through the channel unit are shown in figure 2-1. Because of the many signaling variations, only the functional signaling blocks common to all channel units are shown.

VF Transmission

2.02 In a four-wire channel unit, vf transmit signals enter at pins 38-40 and vf receive signals exit at pins 42-44.

In a two-wire channel unit, a hybrid couples the two-wire port at pins 42-44 to the transmit and receive branches.

2.03 As shown in figure 2-1, the transmit branch includes bridging-pin jack test points for monitoring, level-coordination attenuators, and a normalled-through telephone jack for test access. Variations in this part of the circuit are summarized in Part 3. Standard alignment levels at the 4W XMT and 4W RCV jacks are −16 dBm and +7 dBm, respectively. However, as explained in paragraph 2.10, on channel units marked with a diamond (♦) symbol, the levels are −16.7 dBm and +7.7 dBm.

Figure 1-1. List of Channel Unit Types

Channel Unit	Summarized in Figure	Detailed in GTEP Section 342-911-
91234 Four-Wire SF	3-6	-140
91237 Two-Wire Duplex	3-6	-141
91238 No. 2 EAX	3-6	-142
91240 Four-Wire E&M	3-1	-143
91241 Two-Wire E&M	3-2	-144
91242 Four-Wire	3-5	-145
91243 DPO Loop	3-3	-146
91245 DPT Loop	3-4	-147
91250 Stop Dial/Wink Orig	3-3	-148
91251 ETS-4	3-6	-149
91252 Two-Wire E&M	3-2	-150
91253 DPO Loop	3-3	-151
91254 Four-Wire E&M	3-1	-152
91255 DPT Loop	3-4	-153
91257 Four-Wire Tandem	3-6	-154
91258 FEX Office	3-6	-155
91259 FEX Subscriber	3-6	-155
91290 DPO/ICT	3-6	-156
91291 DPT/OGT	3-6	-156
91402 2-Wire and 91404 4-Wire E&M	——	-114

2.04 From the 4W XMT jack, vf signals continue through the transmit amplifier and a bandpass filter (180-3400 Hz) to the transmit gate. The filter limits the channel frequency band and also rejects any 60-Hz noise induced from power lines onto the external vf drop. Enabled by channel pulses on the CHP-( )T' lead, the transmit gate applies a sample of the instantaneous vf signal amplitude onto the transmit PAM bus every 125 μs. (PAM stands for pulse amplitude modulation.)

2.05 In the receive branch, pulse amplitude modulated signals on the receive PAM bus are time-demultiplexed by the receive gate, enabled every 125 μs by channel pulses on the CHP-( )R' lead. The gate and a 3400-Hz lowpass filter reconstruct the analog channel signal, which is amplified to +7 dBm at the 4W RCV jack.

2.06 In system alignment, the XMT LEV and RCV LEV controls adjust the associated amplifier gain to compensate for variations in the channel bank common equipment. The adjustment range is such that with −16 dBm at the 4W XMT jack, it will be possible to set the level at the 4W RCV jack on the distant channel unit at +7 dBm. On some channel units, the controls have a wider range (up to 6 dB) for drop level adjustment.

2.07 Standard TLP. The CARR jacks on the channel unit are standard transmission level points (TLP): −16 dB at 4W XMT, +7 dB at 4W RCV, and 0 dB transmit at a two-wire jack. (An exception is explained in paragraph 2.10.) Later model channel units include vf amplifiers to compensate for office wiring loss so that standard TLP's can be established external to the channel bank also.

2.08 Transmit and receive attenuators and vf amplifiers coordinate the standard levels at the channel unit transmission level points with the drop levels of the connecting equipment; some typical nominal levels are listed below.

(a) Four-wire facility: −16/+7 dBm.

(b) Two-wire facility: 0/−3 dBm, 0/−5 dBm, 0/−6 dBm, or as locally specified.

(c) Tandem facility: transmit and receive are cross-connected at the drop interface; thus, in each direction, the +7 dBm receive level of one facility must be coordinated with the −16 dBm transmit level of the other.

2.09 Alignment. In channel unit alignment with the 91232 test set, levels and impedances are coordinated by pushing in the test set CHANNEL TYPE SELECT pushbuttons marked with the same geometric symbol as the CARR jacks on the channel unit. Three symbols identify circuit parameters as follows:

	Jack	Transmit Level
●	4W 600Ω	−16 dBm
▲	2W 600Ω	0 dBm
■	2W 900Ω	0 dBm

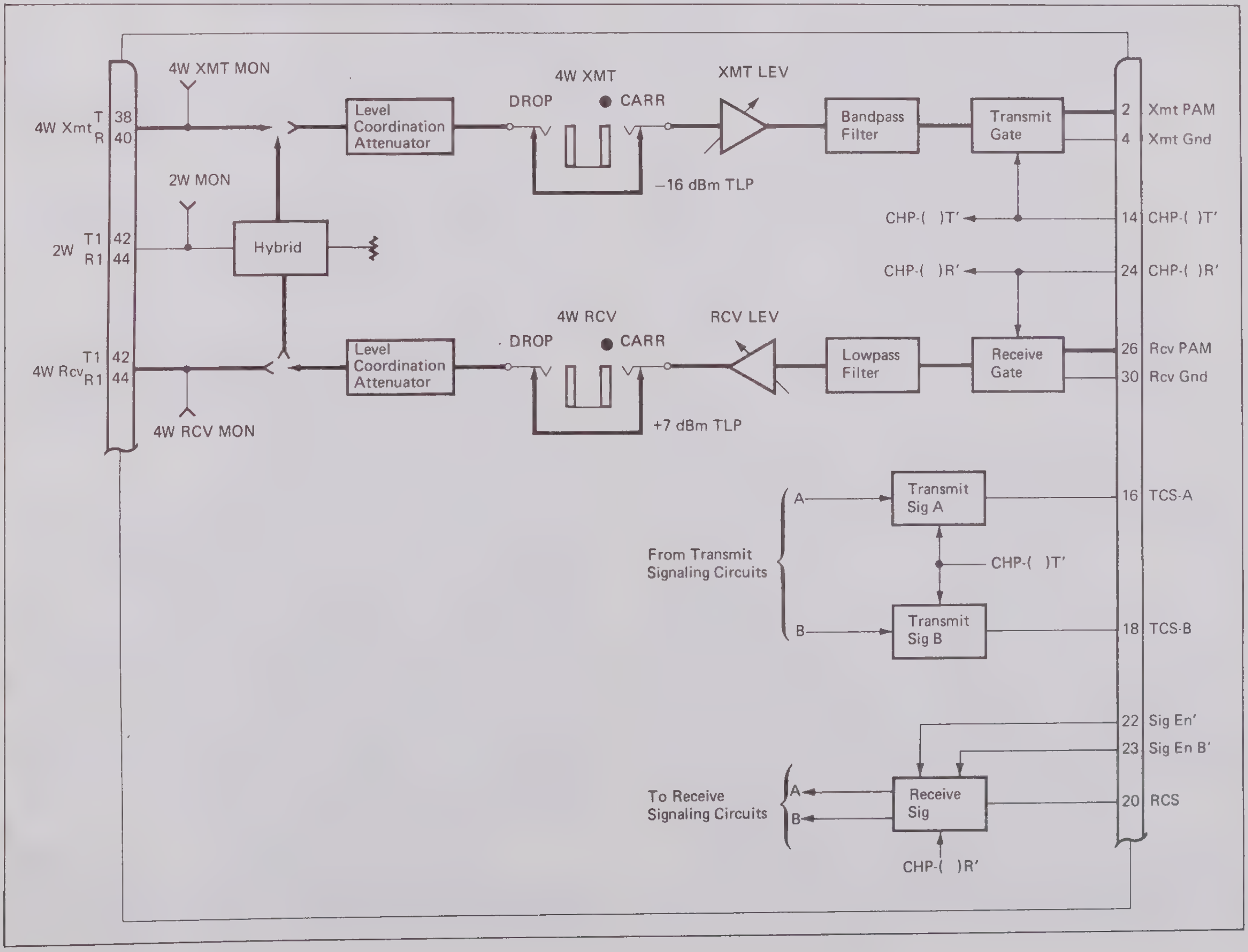
2.10 Channel units marked with a diamond symbol (♦) have a single telephone jack at a 600-ohm impedance point in each branch. The jack is normal-through from tip to ring; the ring faces the drop, the tip faces the carrier, and the sleeve is common ground. In the design of these channel units, balancing transformers at the transmit amplifier input and the receive amplifier output were eliminated or relocated. As a result, the alignment levels differ from −16/+7 by the 0.7-dB transformer insertion loss; that is, −16.7 dBm transmit and +7.7 dBm receive.

2.11 In alignment of a "diamond" channel unit, the 4W 600Ω (●) configuration of the 91232 test set is used. To coordinate levels, the 4W XMT or 4W RCV jack on the channel unit is patched to the test set through a 91256 Test Level Adapter. A 0.7-dB pad in the adapter converts −16.7/+7.7 dBm TLP at the channel unit to −16/+7 dBm TLP at the test set.

2.12 Hybrid Balance (Two-Wire Channel Unit). Incoming signals from the two-wire drop are coupled to the transmit branch, and outgoing signals from the receive branch are coupled to the two-wire drop through a differential or composite hybrid. The differential hybrid is a single transformer with a center-tapped winding on the four-wire side; the composite hybrid has two multiwinding transformers.

2.13 All two-wire channel units have a simple "compromise" network that balances the hybrid for a two-wire drop impedance of 600 or 900 ohms in series with 2.15 μF. (Due to transformer action, the resistance and capacitance in the network for a differential hybrid may be other than 600 or 900 ohms and 2.15 μF.) As an alternative to the compromise network, the composite hybrid is usually connected to an inter-

Figure 2-1. Basic Channel Unit Circuit Diagram


4W XMT MON
4W Xmt
T
R
38
40
Level Coordination Attenuator
4W XMT
DROP
● CARR
XMT LEV
Bandpass Filter
Transmit Gate
2 Xmt PAM
4 Xmt Gnd
−16 dBm TLP
2W MON
2W
T1
R1
42
44
Hybrid
CHP-( )T'
14 CHP-( )T'
CHP-( )R'
24 CHP-( )R'
4W RCV
DROP
● CARR
RCV LEV
4W Rcv
T1
R1
42
44
Level Coordination Attenuator
Lowpass Filter
Receive Gate
26 Rcv PAM
30 Rcv Gnd
+7 dBm TLP
4W RCV MON
A
Transmit Sig A
16 TCS-A
From Transmit Signaling Circuits
CHP-( )T'
B
Transmit Sig B
18 TCS-B
22 Sig En'
23 Sig En B'
To Receive Signaling Circuits
A
B
Receive Sig
20 RCS
CHP-( )R'

nal or external "precision" network, which can be strapped to improve balance over a wider frequency range. The precision network cannot be used with a differential hybrid.

2.14 When required to compensate for the shunt capacitance of the office cabling, a network buildout (NBO) capacitor is connected across the compromise or precision network. Again because of transformer action, the NBO capacitance for a differential hybrid may be several times greater than the capacitance of the two-wire drop.

2.15 Hybrid performance is rated by transhybrid loss and return loss; for either parameter, higher loss (dB) means better performance. Transhybrid loss and various forms of return loss are defined as follows:

(a) Four-wire return loss: measure of the impedance match between the two-wire drop and the balancing network.

(b) Transhybrid loss: measure of the signal loss from the four-wire receive port of the hybrid to the four-wire transmit port. It is equal to the sum of the four-wire return loss, the four-wire to two-wire receive insertion loss, and the two-wire to four-wire transmit insertion loss.

(c) Two-wire return loss: measure of the impedance match between a reference impedance and the impedance looking into the hybrid two-wire port. It is affected by the impedances at the four-wire transmit and receive ports but not the impedance of the balancing network.

(d) Echo return loss (ERL) and singing return loss (SRL): measure of the reflected energy at the near-end two-wire port plus any transhybrid energy returned from the far-end four-wire transmit port.

  (1) ERL is the average of weighted losses between 500 to 2500 Hz; for intertoll and foreign-exchange units it is 28 dB minimum, 33 dB typical; for toll-connecting and subscriber units it is 22 dB minimum, 26 dB typical.

  (2) SRL is the loss in the singing bands, 200 to 500 Hz and 2500 to 3200 Hz.

Signaling

2.16 The details of signaling and supervisory circuits are illustrated and described in the GTE Practices listed in figure 1-1 for individual channel unit types. All the circuits, however, interface at TTL logic levels, with the functional blocks shown in figure 2-1 and described below.

2.17 Transmit Signaling. Binary signaling (and supervisory) information is transmitted as bit-8 of each pcm channel word in the 6th and 12th frames of a 12-frame interval (superframe). This arrangement creates two separate signaling channels, A and B. Enabled by the CHP-( )T' pulses, information is gated onto the TCS-A and TCS-B buses in every frame. However, in the transmit unit of the common equipment, TCS-A and TCS-B are sampled only at bit-8 time in frame 6 and frame 12, respectively.

2.18 Because each signaling channel can have two states (logic 1 or 0), up to four conditions can be transmitted. For example, a foreign-exchange channel unit needs to transmit loop condition (open or closed) on TCS-A and ringing condition on TCS-B simultaneously. But on an E&M channel unit, which only transmits M-lead condition (on-hook or off-hook), the inputs to Transmit Sig A and Transmit Sig B on figure 2-1 would be connected together.

2.19 The bit rate on each signaling channel is 666 b/s, or one sample of the signaling condition every 1.5 milliseconds. If the same information is applied to TCS-A and TCS-B as on E&M channel units, the bit rate is 1,333 b/s or one sample every 0.75 ms. The faster bit rate introduces less distortion. For example, when the transmitted information represents dial pulses at 10 pps and 50-percent break, the width of a dial pulse is 50 ms. Therefore, the peak distortion introduced by the sampling process is 1.5 percent (0.75/50 × 100 = 1.5%); the average distortion is 0.75 percent.

2.20 Receive Signaling. From the receive common equipment unit, the RCS bus distributes a time-division multiplex train of 5.2-μs pulses representing the signaling information of 24 channels. During frames 6 and 12, Sig En' goes to logic 0 to enable sampling of RCS by each channel, in turn. Channel receive pulse CHP-( )R' clocks the logic state of the RCS bus into a flip-flop in the channel unit receive signaling circuit. The flip-flop holds that state until the next signaling frame, when it may be changed or remain the same, according to the logic state of the RCS bus at that time.

2.21 When the channel unit utilizes the A and B signaling channels separately, the receive signaling circuit has two flip-flops. The B flip-flop is clocked with Sig En B', and the A flip-flop is clocked with a Sig En A', created internally by logically subtracting Sig En B' from Sig En'.

2.22 E&M Signaling. The three standard types of E&M signaling interface are illustrated in figure 2-2 and described below.

(a) Type I. This two-wire interface is preferred for electromechanical switching systems. The most common on-hook/off-hook conditions are open/ground outgoing on the E lead and ground/battery incoming on the M lead.

(b) Type II. This is a four-wire fully looped arrangement in which open and closure signals are used in each direction. It is the preferred type for trunk circuits in electronic switching environments.

(c) Type III. This is a partially-looped four-wire interface for use in electronic switching environments where the fully-looped type II cannot be provided. The difference from type II is that the trunk circuit obtains signaling battery and ground from the channel unit over the SB and SG leads.

2.23 At a tandem office, four-wire channel units of different carrier systems may be connected back to back as shown in figure 2-2. The vf transmit and receive pairs and the E&M signaling leads are cross-connected. One unit is strapped as a standard four-wire E&M channel unit with transmit/receive levels of −16/+7 dBm, while the other, strapped as a back-to-back unit, has complementary +7/−16 dBm levels. Two 91257 Four-Wire Tandem Channel Units are used to connect FX and various subscriber channel units in tandem at an intermediate office. Figure 2-2F shows the signaling circuits of two 91257 units in tandem. When tandem connecting to channel units in a 9004A PCM Channel Bank, refer to GTEP Section 342-911-114 (91402 2-Wire and 91404 4-Wire E&M Channel Units). This GTEP provides information on alternate pulse link repeater (PLR) cross-connect arrangements.

2.24 If the signaling interface uses type I leads, the E&M unit is strapped for open/ground on the E lead and ground/battery on the M lead. Accordingly, the back-to-back unit is strapped to accept open/ground on its M lead and to

Figure 2-2. E&M Signaling Interface (Sheet 1 of 2)

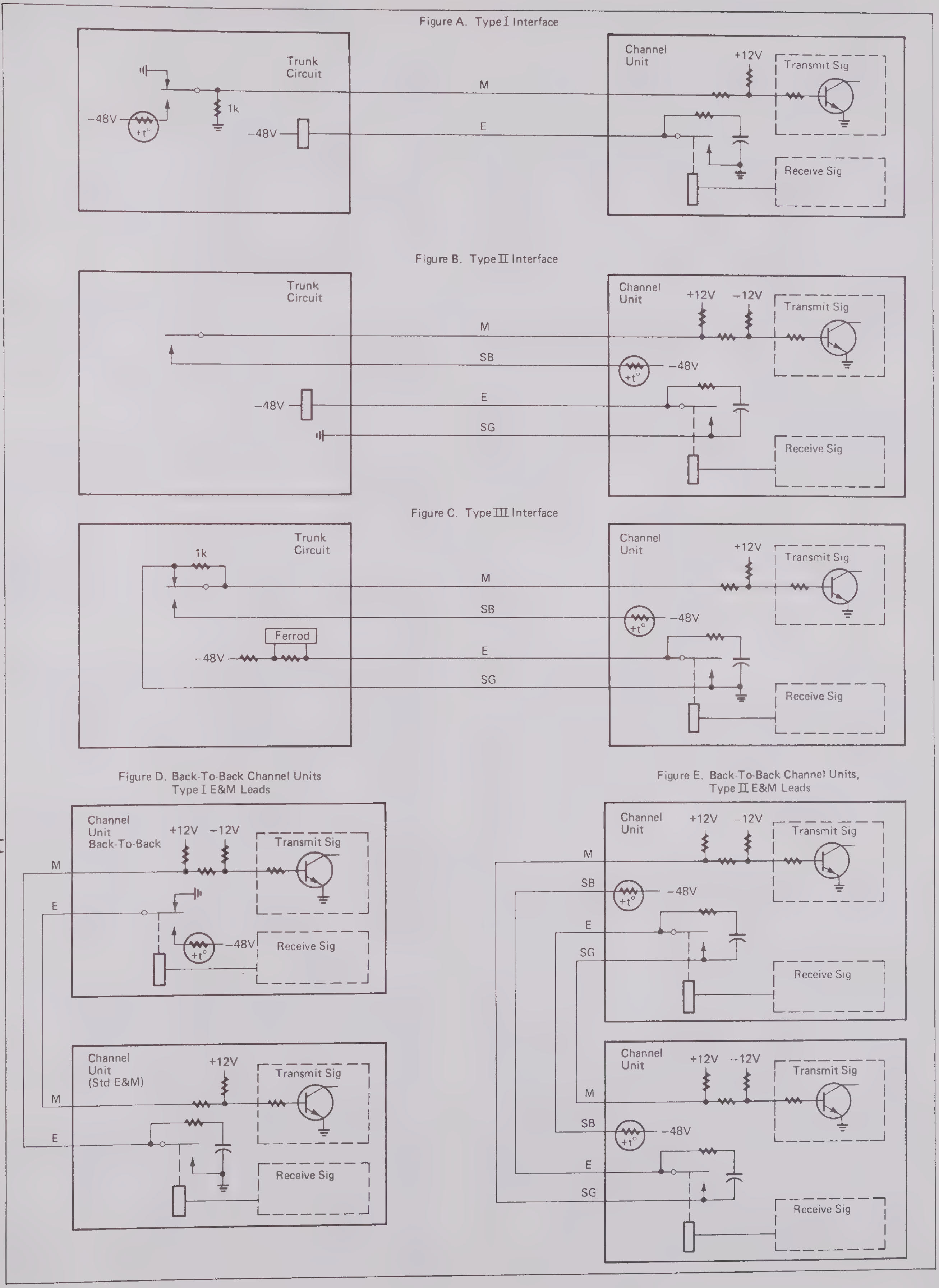


Figure A. Type I Interface
Trunk Circuit
-48V
+t°
1k
-48V
M
E
Channel Unit
+12V
Transmit Sig
Receive Sig
Figure B. Type II Interface
Trunk Circuit
M
SB
-48V
E
SG
Channel Unit
+12V
-12V
Transmit Sig
+t°
-48V
Receive Sig
Figure C. Type III Interface
Trunk Circuit
1k
M
SB
Ferrod
-48V
E
SG
Channel Unit
+12V
Transmit Sig
+t°
-48V
Receive Sig
Figure D. Back-To-Back Channel Units Type I E&M Leads
Channel Unit Back-To-Back
+12V
-12V
Transmit Sig
M
E
+t°
-48V
Receive Sig
Channel Unit (Std E&M)
+12V
Transmit Sig
M
E
Receive Sig
Figure E. Back-To-Back Channel Units, Type II E&M Leads
Channel Unit
+12V
-12V
Transmit Sig
M
SB
+t°
-48V
E
SG
Receive Sig
Channel Unit
+12V
-12V
Transmit Sig
M
SB
+t°
-48V
E
SG
Receive Sig

Figure 2-2. E&M Signaling Interface (Sheet 2 of 2)

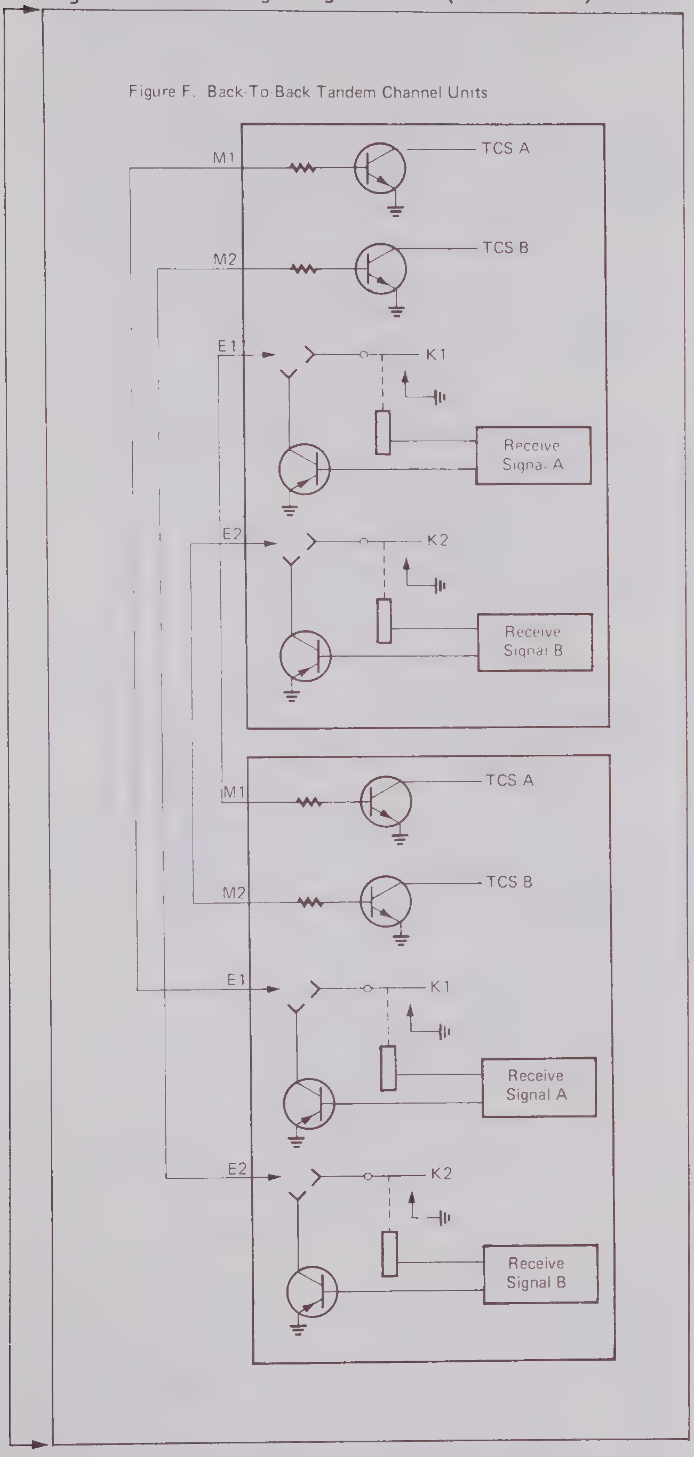


Figure F. Back-To Back Tandem Channel Units

output ground/battery on its E lead. With type-II E&M leads, the signaling circuits in the back-to-back channel units are arranged the same; the receive circuit provides open/closed relay contacts and the transmit circuit responds to open/battery.

2.25 The channel unit determines the M-lead cabling resistance limit, and the trunk circuit determines the E-lead limit. The objective limit for E&M leads in new type-I or type-III interfaces is 100 ohms; older circuits have upper limits as low as 25 ohms. The objective limit for E&M leads in type-II interfaces is 300 ohms loop (150 ohms one way).

2.26 Loop Signaling. The basic loop signaling circuit is a series circuit that provides one signaling state when it is opened (on-hook) and another when it is closed (off-hook). A third state obtained by reversing the direction of current in the circuit can convey answer supervision over the carrier channel from a dial pulse terminating (DPT) channel unit to a dial pulse originating (DPO) channel unit.

2.27 Normal battery polarity on the trunk loop is positive (ground) on the tip and negative (– 48V) on the ring. When a called party answers, polarity is reversed. This is detected by the DPT channel unit, which transmits an off-hook signal to the DPO. The DPO channel unit repeats the reverse battery polarity at the originating end.

2.28 Controlled Outpulsing. On a trunk arranged for sender-controlled outpulsing, after seizure, the originating office does not transmit dial pulses until it has received an indication that a register or sender is attached at the called office. Typically, if the indication is not received within 4 seconds (busy hour) or 15 seconds (nonbusy hour), the originating office will disconnect. Two methods of controlled outpulsing are "delay dial" and "wink start."

2.29 In the delay-dial method, the called office returns an off-hook (stop-dial) signal within 70 ms after seizure. When ready to accept pulsing (but not before a delay of at least 140 ms), the called office goes on-hook as a start-dial signal to the originating office. Delays are longer for multifrequency pulsing.

2.30 With the wink-start method, the called office does not acknowledge seizure, but returns a wink signal when it is ready to accept pulsing. The wink consists of (1) on-hook to off-hook transition, (2) off-hook period of 140 to 290 ms, and (3) off-hook to on-hook transition.

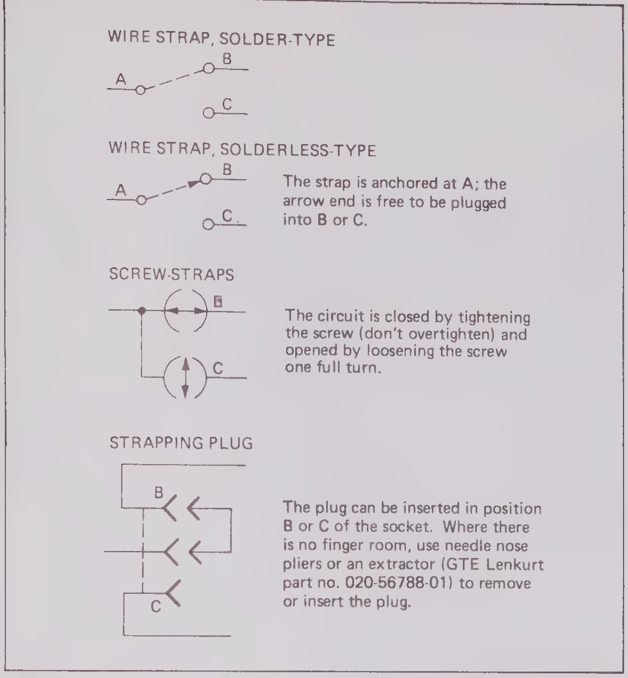
2.31 Signaling Integrity Check. Signaling integrity check is a per-call test made by an originating common control office during the initial call setup to a terminating SxS (step-by-step) switching system. It is used as an indication of the availability of the SxS incoming selector to receive pulses. The wink signal described above serves as the signaling integrity check. The 91255-02 DPT channel unit provides this function for SxS offices.

2.32 Calling Party Forces Release (CPFR). Normally, the release of an established connection is controlled by the calling party. If the calling party fails to go on-hook when the called party does, the originating trunk and switchtrain will be held. The terminating trunk also may be held, preventing release of the called party. To circumvent this situation, a CPFR circuit is included in the switching equipment of the outgoing channel unit at the originating office.

2.33 CPFR is used normally on toll-connecting trunks and frequently on direct trunks. Because CPFR may not be available with all types of switching equipment (step-by-step for example), it is provided on some DPO channel units. When activated, the CPFR circuit preempts control of the switchtrain and, after a timed interval, removed ground from the C lead, dropping the calling party and releasing the associated equipment for other service.

2.34 Trunk Make Busy. Basically, the channel bank has two mechanisms for conditioning the switching equipment when the system is experiencing abnormal conditions. First, the 91222 receive unit preempts control of all channels by forcing an on-hook or off-hook condition on the RCS signaling bus. And second, the 91230 alarm unit grounds the TMB' lead, causing individual channel units to go on-hook or off-hook according to channel unit design and application. (Forcing all channels off-hook ensures that there will be no

Figure 2-3. Graphic Symbols for Electrical Straps



WIRE STRAP, SOLDER-TYPE

WIRE STRAP, SOLDERLESS-TYPE

The strap is anchored at A; the arrow end is free to be plugged into B or C.

SCREW-STRAPS

The circuit is closed by tightening the screw (don't overtighten) and opened by loosening the screw one full turn.

STRAPPING PLUG

The plug can be inserted in position B or C of the socket. Where there is no finger room, use needle nose pliers or an extractor (GTE Lenkurt part no. 020-56788-01) to remove or insert the plug.

disconnects on trunks in use. However, if the 91222 receive unit is strapped for off-hook and all channels are idle when the carrier fails, there will be 24 seizures into the switching equipment.)

2.35 The sequence of events that may take place in a transient or long-term alarm situation are outlined below.

(a) On the 91222 receive unit (model 4 or later), a mute circuit is activated by a frame search or a remote alarm. An unsuccessful frame search will result in a local alarm. After a 70-ms delay, vf receive in each channel is muted via the PAM bus and signaling is clamped on-hook or off-hook (strapping option) via the RCS bus. The delay of 70 ms is time enough for at least one reframing attempt, or perhaps two or three.

(b) If the alarm condition persists, after additional delay, the AC-6' lead from the 91230 alarm unit to the 91222 receive unit forces RCS on-hook, regardless of the mute circuit option. By strapping options, the minimum delay until AC-6' activation is 50 or 300 ms for a local alarm and 75 or 400 ms for a remote alarm. An additional 2-second delay can be inserted by another strapping option.

(c) At the same time as the AC-6 alarm, or after an additional 1-second delay (strapping option), the system alarm relay on the 91230 alarm unit releases, grounding the TMB' bus.

NOTE: The alarm sequence described above is applicable, beginning with the 91222-M4 receive unit and the 91230-M3 alarm unit. The 91222-M1 receive unit does not have a mute circuit; the -M2 and -M3 units have a mute circuit that forces RCS on-hook. In the 91230-M1 and -M2 alarm units, the delay to a system alarm is 350 ms for a local alarm condition and 1.5 seconds for a remote alarm condition; there is no optional 1-second delay between an AC-6 alarm and the system alarm.

(d) Ground on TMB' may affect signaling or supervision (C/OS lead), or both, in individual channel units. The TMB alarm overrides the AC-6 alarm. In a typical DPO channel unit, the trunk circuit C lead is grounded immediately, opened momentarily after a delay to release the switchtrain, and finally grounded again to make the channel busy for the duration of the alarm.

2.36 Most channel units have a NORM/BUSY switch to condition the trunk during channel alignment and testing; some have an LED to indicate switch position or channel status. Depending on the type of channel unit and its application, the BUSY position of the switch may make the channel idle or busy towards the carrier and towards the drop. Generally, the originating end of the trunk is made busy and the terminating end is made idle. This feature may not be found on other manufacturers' pcm channel banks. For example, WECo D1D, D2, and D3 channel banks do not have busy switches, but they can be made busy by the NORM/BUSY switch on some 9002-type channel units at the remote end; for example, a 91245 or 91255 DPT channel unit to a WECo originating channel unit.

2.37 Unplugging a channel unit closes two pairs of switching contacts (31-32 and 33-34) on the shelf receptacle connector. By appropriate strapping, these contacts are utilized to make the local channel appear idle or busy through the C/OS and E leads. The remote channel will always appear off-hook.

Strapping

2.38 Four types of electrical straps used in the channel bank equipment are illustrated and described in figure 2-3.

3. CHANNEL UNIT APPLICATIONS

3.01 Figure 1-1 lists channel units in type number order and references the figure in this Section where the unit is summarized and the Section where it is detailed. Figures 3-1 through 3-6, which classify channel units according to type of drop interface, give principal characteristics, features, and applications. Channel unit options and models which do not have their vf paths illustrated are either earlier versions or are versions illustrated but without switchable pads and/or jacks. Details of these units are contained in the practices listed in figure 1-1.

3.02 In figures 3-1 through 3-5, the channel unit service grade is specified as intertoll or toll-connecting. The channel unit may also be used for service of a lower grade; that is, an intertoll channel unit for a toll-connecting or exchange trunk and a toll-connecting channel unit for an exchange trunk.

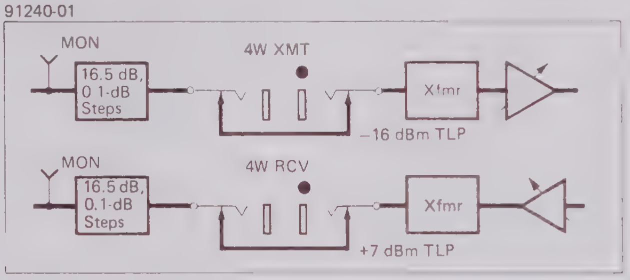
3.03 Figures 3-3 and 3-4 provide an information summary for Dial Pulse Originating (DPO) Loop Channel Units and Dial Pulse Terminating (DPT) Loop Channel Units. While the 91243 DPO is commonly paired with the 91245 DPT and the 91253 DPO is paired with the 91255 DPT, the 9002A units can be used end-to-end with the 9002B units (e.g., 91243 DPO paired with 91255 DPT, 91253 DPO with 91245 DPT). The 9002B units (91253-02 M2 and 91255-02 M2) have, for most applications, replaced the older 9002A equivalents, the 91243 DPO and the 91245 DPT. The usage and choice of combinations for these units are limited by the available features provided by each unit. Feature information can be found by referring to the applicable GTEP listed in figure 1-1.

3.04 The 91245-01 and 91255-02 can sense reverse battery only when seized. The 91255-01 has its reverse battery sensor across the drop rather than ahead of the loop closure "P" relay. Therefore, it may be used on trunks that require reverse battery to be returned in the idle state.

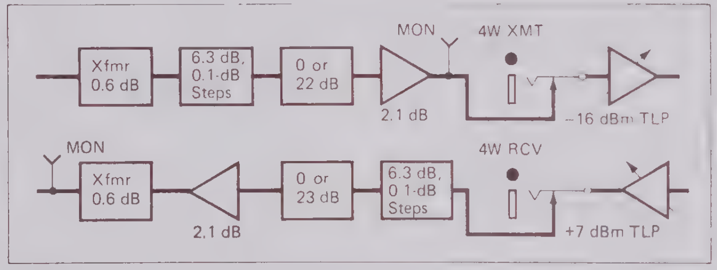
Figure 3-1. Four-Wire E&M Channel Units

Type		91240			91254			
		–01	–02	–04	–01 Model 1	–01 Model 2	02	03, –04
Drop impedance		600 ohms			600 ohms			
Transmit drop level, dBm		–16	–16	–16 or +7	–16		–16 or +7	
Receive drop level, dBm		+7	+7	+7 or –16	+7		+7 or –16	
Level coordination atten		16.5 dB	NA	32.5 dB	NA		4.8 dB	
Office loss compensation		NA			NA		1.5 dB	
Signaling interface type		I		I, II	I		I, II, III	
On-hook/off-hook options, type I interface	E lead	O/G, G/O, G/B, B/G		O/G, G/B	O/G		O/G, G/B	
	M lead	G/B, O/G		G/B, O/G	G/B		G/B, O/G	
Auxiliary sig/supv leads	Pin 32	C, OS		C, OS, SG	OS, B1	C, OS, B1	SG	SG C, OS
	Pin 35	F		F, SB	–		SB	SB
	Pin 41	–		–	B2		–	B2
Service grade		Intertoll			Intertoll			

91240-01


MON
16.5 dB, 0.1-dB Steps
4W XMT
Xfmr
–16 dBm TLP
MON
16.5 dB, 0.1-dB Steps
4W RCV
Xfmr
+7 dBm TLP

91254-02


Xfmr 0.6 dB
6.3 dB, 0.1-dB Steps
0 or 22 dB
2.1 dB
MON
4W XMT
–16 dBm TLP
MON
Xfmr 0.6 dB
2.1 dB
0 or 23 dB
6.3 dB, 0.1-dB Steps
4W RCV
+7 dBm TLP

NOTES:

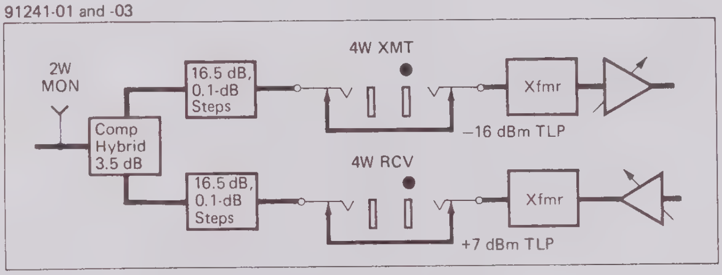
1. Drop Levels. Transmit and receive levels are with level coordination attenuators strapped for 0 dB.
2. Tandem Operation. The 91240-04, and 91254-02, -03 and -04 channel units can be strapped for direct back-to-back connection with E&M channel units in other carrier systems. VNL can be inserted by level coordination attenuators.
3. Trunk Make Busy. All channel units have a TMB circuit activated by a channel bank system alarm or by the NORM/BUSY switch. The TMB circuit can be strapped to make the channel idle or busy during alarm.

   In addition, the 91254-02, -03 and -04 channel unit has a BUSY indicator and strapping options in which the alarm condition is idle, busy, or busy after 10 seconds forced idle.
4. E&M Lead Conditions. B, G, and 0 stand for battery, ground, and open.

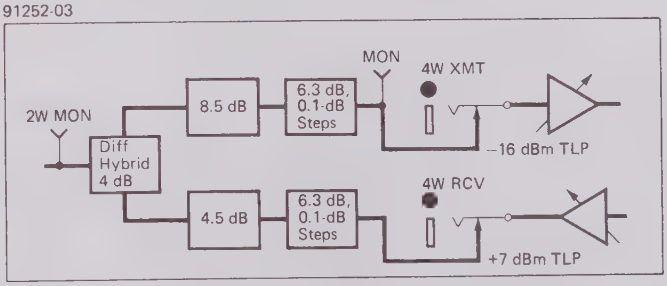
Figure 3-2. Two-Wire E&M Channel Units

Type		91241				91252			
		–01	–03	–02	–04	–01	–02	–03	–04
Drop impedance (plus 2.15 μF)		900 ohms	600 ohms	900 ohms	600 ohms	900 ohms	600 ohms	900 ohms	
Transmit drop level, dBm		–12.5 to +4		0		0		–3.5 to +2.8	–3 to 0
Receive drop level, dBm		+3.5 to –13		–2 to –3		–3 to –5		–1.5 to –7.8	–1 to –6
Level coordination atten		16.5 dB		NA		2 dB		4.8 dB	NA
Office loss compensation		NA		NA		0.75 dB		1.5 dB	NA
Signaling interface type		I				I		I, II, III	I
On-hook/off-hook options, type I interface	E lead	O/G, G/O, G/B, B/G				O/G		O/G, G/B	O/G
	M lead	G/B, O/G				G/B		G/B, O/G, O/B	G/B
Auxiliary sig/supv leads	Pin 32	C, OS				B1, OS		C, OS, SG	C, OS
	Pin 35	F				—		SB	—
	Pin 39	A				—		A	
	Pin 41	B				B2		B	
Hybrid		Composite hybrid; compromise network or external precision network				Differential hybrid; compromise network			
NBO capacitor		Internal; strap 0.003 to 0.093 μF		External		None		Internal; install as required	
Service grade		Intertoll				Toll-connecting; see Note 3			

91241-01 and -03


2W
MON
Comp
Hybrid
3.5 dB
16.5 dB,
0.1-dB
Steps
4W XMT
Xfmr
–16 dBm TLP
16.5 dB,
0.1-dB
Steps
4W RCV
Xfmr
+7 dBm TLP

91252-03


2W MON
Diff
Hybrid
4 dB
8.5 dB
6.3 dB,
0.1-dB
Steps
MON
4W XMT
–16 dBm TLP
4.5 dB
6.3 dB,
0.1-dB
Steps
4W RCV
+7 dBm TLP

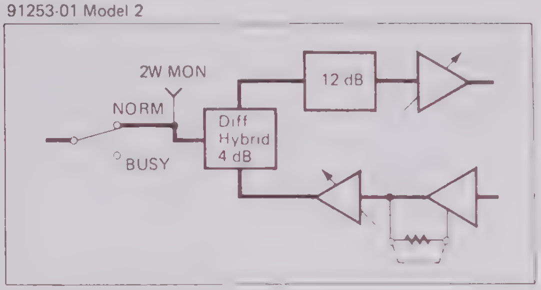
NOTES:

1. Trunk Make Busy. All channel units have a TMB circuit activated by a channel bank system alarm. Features of individual channel units are listed below.
    a. 91241: has C/OS alarm lead and a NORM/BUSY switch; alarm condition is optionally idle or busy.
    b. 91252-01 and -02: has OS/B1-B2 alarm leads; alarm condition is busy.
    c. 91252-03/-04: has C/OS alarm lead, BUSY indicator, and NORM/BUSY switch; alarm condition is optionally idle, busy, or busy after 10 seconds forced idle.
2. E&M Lead Conditions. B, G, and O stand for battery, ground, and open.
3. 91252-03 Channel Unit. Meets intertoll service objectives with the A and B leads driven by a trunk-repeater "A" relay.

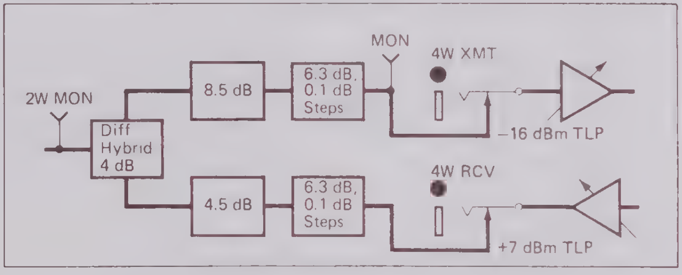
Figure 3-3. Dial Pulse Originating (DPO) Loop Channel Units

Type		91243			91250	91253 Model 2	
		Model 2	Model 3	Model 4	–01	–01	–02
Drop impedance		900 ohms plus 2.15 µF					
Transmit drop level, dBm		0			0	–3 to 0	–3.5 to +2.8
Receive drop level, dBm		–2 to –6	0 to –6		–2 to –6	–1 to –6	–1.5 to –7.8
Level coordination atten		NA			NA	NA	4.8 dB
Office loss compensation		NA			NA	NA	1.5 dB
Auxiliary sig/supv leads	Pin 32	B1, C			C	B1, C, or OS	C
	Pin 34	ATB			ATB	Peg Count	ATB
	Pin 36	EC			EC	–	EC
	Pin 39	–		T	Bsy-1	–	–
	Pin 41	B2		R	Syn	B2	–
Hybrid		Differential hybrid; compromise network					
NBO capacitor		External		Internal as required			
Features		CPFR TMB – Delay dial or wink start			CPFR TMB – Stop dial or wink start	– TMB BUSY ind Delay dial or wink start CLR hold	CPFR TMB BUSY ind Delay dial or wink start CLR hold Vf port with nonreverse bat. option
Service grade		Toll-connecting					

91253-01 Model 2



91253-02 Model 2



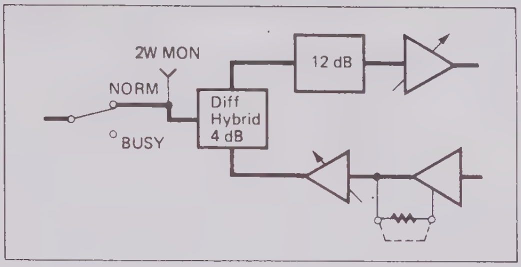
NOTES:

1. Applications. Principal applications of the channel units are as follows:
   - a. 91243-01: operates from outgoing three- or four-wire SxS selector and from no. 5 crossbar; contains the equivalent of a one-way outgoing trunk repeater.
   - b. 91250-01: operates from outgoing four-wire selector tied to a ticketer or directly from a ticketer; limited to a Class 5 office.
   - c. 91253-01: same as Note 1a except three-wire only.
   - d. 91253-02: same as Note 1a.

Figure 3-4. Dial Pulse Terminating (DPT) Loop Channel Units

Type		91245	91255 Model 2	
		–01	–01	–02
Drop impedance		900 ohms plus 2.15 μF		
Transmit drop level, dBm		0	–3 to 0	–3.5 to +2.8
Receive drop level, dBm		–2 to –6	–1 to –6	–1.5 to –7.8
Level coordination atten		NA	NA	4.8 dB
Office loss compensation		NA	NA	1.5 dB
Auxiliary sig/supv leads	Pin 32	–	–	C
	Pin 36	Bsy Back	–	Bsy Back
Hybrid		Differential hybrid; compromise network		
NBO capacitor		Internal; install as required		
Features			BUSY ind TMB	BUSY ind TMB Sig integrity check ckt Pulse corrector (Code option)
Service grade		Toll-connecting		

91255-01 Model 2


2W MON
NORM
BUSY
Diff
Hybrid
4 dB
12 dB

NOTES:

1. Applications of the 91255-02:
   a. Designed to operate as an incoming loop unit in any office.
   b. Provides signaling integrity check function when used as a terminating unit in a SxS office.
   c. Suitable for tandem pulsing.

91255-02 Model 2

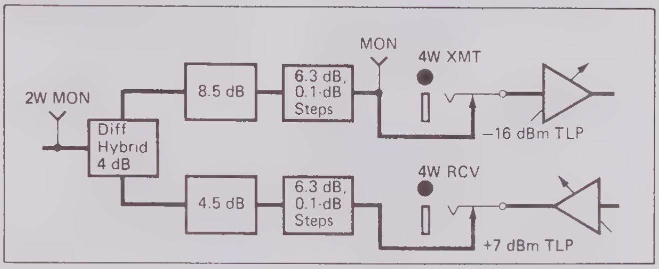
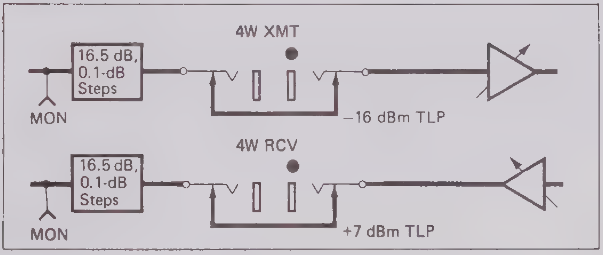

2W MON
Diff
Hybrid
4 dB
8.5 dB
6.3 dB,
0.1-dB
Steps
MON
4W XMT
–16 dBm TLP
4.5 dB
6.3 dB,
0.1-dB
Steps
4W RCV
+7 dBm TLP

Figure 3-5. Four-Wire Transmission-Only Channel Units

Type	91242		
	–01	–02	–03
Drop impedance	600 ohms		
Transmit drop level, dBm	–16 to +0.5	–16	–16 or +7
Receive drop level, dBm	+7 to –9.5	+7	+7 or –16
Level coordination atten	16.5 dB	NA	4.8 dB
Office loss compensation	NA	NA	1.5 dB
Service grade	Intertoll		
Applications	Inband signaling trunks; CCIS (common channel interoffice signaling)		

91242-01


16.5 dB,
0.1-dB
Steps
4W XMT
MON
–16 dBm TLP
16.5 dB,
0.1-dB
Steps
4W RCV
MON
+7 dBm TLP

91242-03

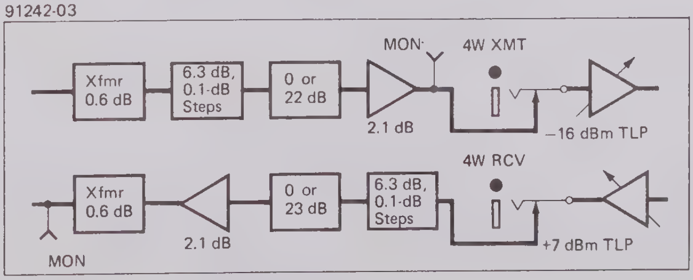
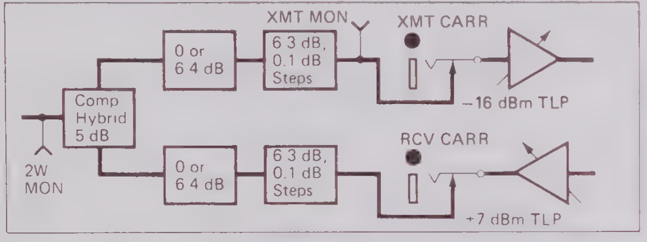

Xfmr
0.6 dB
6.3 dB,
0.1-dB
Steps
0 or
22 dB
2.1 dB
MON
4W XMT
–16 dBm TLP
Xfmr
0.6 dB
2.1 dB
0 or
23 dB
6.3 dB,
0.1-dB
Steps
4W RCV
+7 dBm TLP
MON

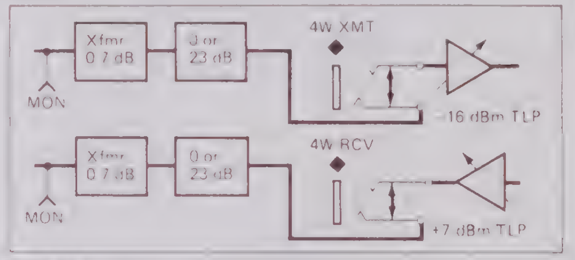
Figure 3-6. Special Purpose Channel Units

Type	Name	Drop Impedance, Ohms	Drop Levels, dBm		Applications
			Transmit	Receive	
91234-01	4W SF	600	+5.5 to +7	−14.5 to −16	For extending fdm carrier channels with sf signaling over pcm carrier or to a digital switch; 2600-Hz signaling tone supply is required
91237-01	2W DX	900	−11 to +1.7	+2 to −10.7	For extending physical duplex trunks over pcm carrier or to a digital switch
91238-01	No. 2 EAX	900	−1.5 to +4.8	−1.5 to −7.8	Trunk circuit for no. 2 EAX; 91330-04 shelf is required
91251-01	ETS-4	600	−16 to +0.5	+7 to −9.5	Used with ETS 4 switching machine or TSPS trunk connected to ETS 4; 91330-03 shelf is required
91257-01	4W Tandem	600	−16 or +7	+7 or −16	For tandem connecting pcm carrier channels that require independent A and B signaling channels; for example, foreign exchange
91258-01 Models 1 and 2	FXO	900 (M1) 900/600 (M2)	−12 to 0 (M1) −11 to +1.7 (M2)	+3 to −9 (M1) +2 to −10.7 (M2)	For foreign-exchange and PBX trunks, loop start or ground start; ringing supply is required for 91259 FXS unit
91258-02 Model 1		600	−12 to 0 (M1)	+3 to −9 (M1)	
91259-01 Models 1 and 2	FXS	900 (M1) 900/600 (M2)	−12 to 0 (M1) −11 to +1.7 (M2)	+3 to −9 (M1) +2 to −10.7 (M2)	
91259-02 Model 1		600	−12 to 0 (M1)	+3 to −9 (M1)	
91290-01	DPO/ICT	900	−11 to +1.7	+2 to −10.7	Interfaces physical loop trunks to a digital switch
91291-01	DPT/OGT	900	−11 to +1.7	+2 to −10.7	

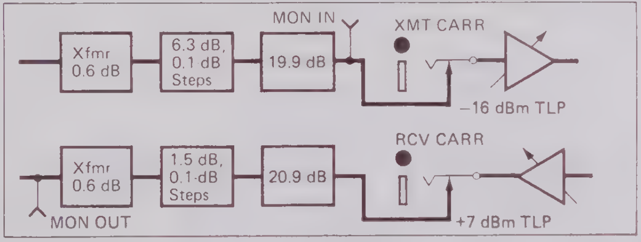
91237-01, 91290-01, 91291-01


XMT MON
XMT CARR
0 or 6.4 dB
6.3 dB, 0.1 dB Steps
Comp Hybrid 5 dB
−16 dBm TLP
RCV CARR
2W MON
0 or 6.4 dB
6.3 dB, 0.1 dB Steps
+7 dBm TLP

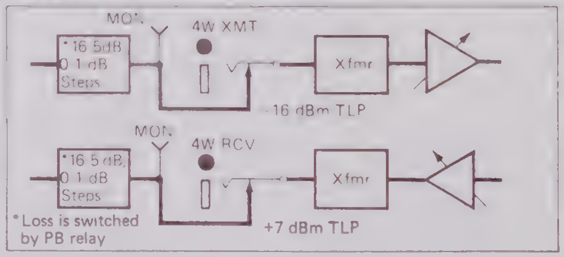
91257-01


Xfmr 0.7 dB
0 or 23 dB
4W XMT
MON
−16 dBm TLP
4W RCV
Xfmr 0.7 dB
0 or 23 dB
MON
+7 dBm TLP

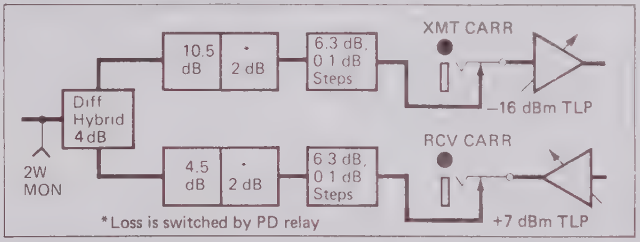
91234-01


MON IN
XMT CARR
Xfmr 0.6 dB
6.3 dB, 0.1 dB Steps
19.9 dB
−16 dBm TLP
RCV CARR
Xfmr 0.6 dB
1.5 dB, 0.1-dB Steps
20.9 dB
MON OUT
+7 dBm TLP

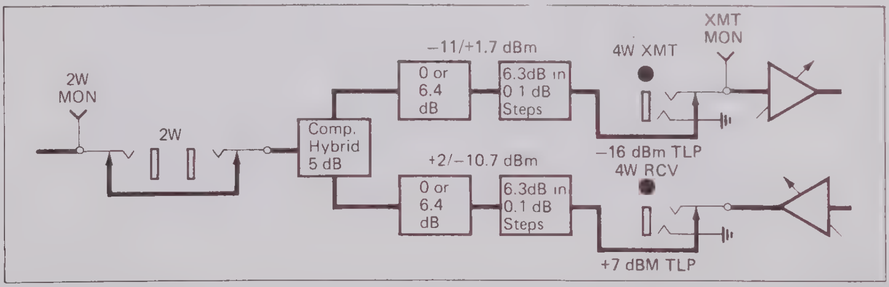
91251-01


MON
4W XMT
*16.5dB 0.1 dB Steps
Xfmr
−16 dBm TLP
MON
4W RCV
*16.5 dB, 0.1 dB Steps
Xfmr
*Loss is switched by PB relay
+7 dBm TLP

91238-01


XMT CARR
10.5 dB
* 2 dB
6.3 dB, 0.1 dB Steps
Diff Hybrid 4 dB
−16 dBm TLP
RCV CARR
2W MON
4.5 dB
* 2 dB
6.3 dB, 0.1 dB Steps
*Loss is switched by PD relay
+7 dBm TLP

91258-01 and 91259-01 Model 2


XMT MON
−11/+1.7 dBm
4W XMT
0 or 6.4 dB
6.3dB in 0.1 dB Steps
2W MON
2W
Comp. Hybrid 5 dB
+2/−10.7 dBm
−16 dBm TLP
4W RCV
0 or 6.4 dB
6.3dB in 0.1 dB Steps
+7 dBM TLP

4. CHANNEL BANK DC POWER

4.01 Channel bank dc power is obtained from the 48-volt office battery. Three lower voltages (+5V, +12V, and −12V) are derived from −48V by the 91235-02 Power Supply Unit and distributed to the common equipment units and the channel units. The 91230 alarm unit and many channel units also use −48V directly.

4.02 Figure 4-1 illustrates how to calculate the load on the office battery for a particular 9002B channel bank configuration. The figure shows the current drain with no channel units plugged in (800 mA) and the additional current drain produced by each type of channel unit. The value listed for a DPO or FXS channel unit does not include current to the external loop; this must be estimated and entered in the space provided.

Figure 4-1. Sample Calculation of 9002B Channel Bank Load on Office Battery

Channel Unit		Qty of Units	Total Current, mA
Type	mA/Unit		
(Common equipment)			800
91234 4W SF	16	12	192
91237 2W DX	26		
91238 No. 2 EAX	65		
91240 4W E&M	25		
91241 2W E&M	24		
91242 4W	15		
91250 Stop Dial/Wink	30		
91251 ETS-4	20		
91252 2W E&M	25		
91253 DPO	40	6	240
Loop current	100		600
91254-01 4W E&M	11		
91254-02 4W E&M	20		
91254-03/-04 4W E&M	43		
91255-01 DPT	41		
91255-02 DPT	28		
91257 4W Tandem	33		
91258 FXO	75		
91259 FXS	82	6	492
Loop current	70		420
91290 DPO/ICT	28		
Loop current	---		
91291 DPT/OGT	33		
Total Load on Office Battery			2.74A

NOTES:

1. Currents are based on office battery at 52 volts.
2. Loop currents are to be based on actual operating conditions. Loop resistance in channel unit is about 400 ohms.

5. TEST EQUIPMENT AND TOOLS

5.01 Test equipment recommended for installation, alignment, and maintenance of the channel bank is listed in figure 5-1. The following special tools are furnished with each 91330 Terminal Equipment Shelf:

(a) Extractor 022-55382-01 (for channel units)
(b) Extractor 020-56788-01 (for strapping plugs)

91249 Channel Unit Extender

5.02 In use, the 91249 extender (figure 5-2) is plugged into a channel unit mounting position in the shelf and the channel unit is plugged into the extender. The 91249-01 extender, used for troubleshooting, provides access to supervisory and power leads at pin jack test points. The vf and E&M signaling circuits are accessible in both directions at normal-through miniature telephone jacks.

5.03 The 91249-02 extender provides originating-end test capability for channel unit CPFR (calling party forced release), wink start, delay dial, and stop dial functions. In testing, the channel unit 2-WIRE jack is patched to the extender CARR jack. A telephone dial can be inserted in the two-wire loop at the DIAL jack.

5.04 Pushing the SEIZE button on the 91249-02 extender closes the loop through current-limiting resistor R1 and lights the LOOP CLOSED indicator. When the channel unit grounds the C lead, the C relay operates and locks up to maintain loop closure; the C-LEAD GND indicator lights. The channel unit receive signaling state is under control of the SUPVN pushbutton, which applies +5V or ground to the RCS lead for on-hook or off-hook, respectively. For detailed operating instructions, refer to the applicable channel unit manual listed in figure 1-1.

91256 Test Level Adapter

5.05 The 91256 Test Level Adapter (figure 5-3) is used to patch the TRANSMIT or RECEIVE jack on the 91232 test set to the 4W XMT or 4W RCV jack on channel units marked with a diamond symbol (♦). A locking-type pushbutton on the adapter has DROP and CARR positions. In the DROP position, the test set jack is connected through the adapter to the drop side (ring and sleeve) of the channel unit jack. In the CARR position, the test set jack is connected through a 0.7-dB pad in the adapter to the carrier side (tip and sleeve) of the channel unit jack. The pad coordinates the −16/+7 dBm test set levels with the −16.7/+7.7 dBm channel unit levels.

Figure 5-1. Recommended Test Equipment

Qty per Site	Test Equipment (GTE Lenkurt unless otherwise specified)	Notes	Description and Use
1	91232-XX Test and Alignment Set		Supplies 1025-Hz analog test tone to channel unit vf jacks; provides interface between external test equipment and channel unit vf jacks; inserts digital test signals for selected channels in the receive 1.544-Mb/s bit stream; furnishes —48V at 0.25A to external equipment. The test set may be rack-mounting or portable and the numbering of the CHANNEL POSITION thumbwheel switches may conform to the D2 or D3 channel sampling sequence as follows: -01 Rack-mounting; D2 sequence -02 Portable; D2 sequence -03 Rack-mounting; D3 sequence -04 Portable; D3 sequence Includes Alignment Cord 035-91232-01 2.7 metres (9 feet) long for interconnection with channel bank, and the following plugs and cords: 6000A-01 600-Ohm Terminating Plug 6000A-02 900-Ohm Terminating Plug 6100B-02 Cord (qty 2) 6100C-02 Cord (qty 2) 6100D-02 Cord Rack-mounted test set can serve three standard rack assemblies; cords furnished with test set are long enough to reach channel banks in adjacent bay on either side.
1	91249-01 Channel Unit Extender		For troubleshooting.
1	91249-02 Channel Unit Extender	1	For testing.
2	91256 Test Level Adapter	2	Used to connect 91232 test set to four-wire jacks on certain channel units; coordinates test-tone levels and jack circuits.
1	26600 Signaling Test Set		Sends signaling pulses at selected rate and percent break; receives signaling pulses and measures percent break.
1	Northeast Electronics TTS-37B Noise Measuring Set		Noise and level measuring test set with switch-type weighting networks and hold coil; for level measurements more accurate than ±0.25 dB, use Hewlett-Packard 400EL ACVM, or equivalent.
1	Northeast Electronics TTS-58A (or TTS-58A-CN) Impulse Noise Counter		Counts number of impulses exceeding a selected level over a selected time interval.
1	Hewlett-Packard 204C Oscillator		For frequency response tests, 200 to 3400 Hz at 0 dBm.
1	Simpson 260-6 Volt-Ohm-Milliammeter		General purpose multimeter with 20,000-ohms/volt sensitivity.
1	725A Cord		Two-conductor cable 3.6 metres (12 feet) long, wired between tip and sleeve of two 310-type tip-ring-sleeve telephone plugs; used to supply —48V power to 26600, TTS-37B, and TTS-58A.
1	729A Cord		Shielded two-conductor cable 2.4 metres (8 feet) long with a twin pin plug on one end and a 310-type tip-ring-sleeve telephone plug on the other end; for connecting to channel unit pin jacks.
1	729B Cord		Shielded two-conductor cable 2.4 metres (8 feet) long with a twin pin plug on one end and a miniature tip-ring-sleeve telephone plug on the other end; for connecting to channel unit pin jacks.
1	6000A-01 600-Ohm Terminating Plug	3, 4	Miniature telephone plug with a 600-ohm resistor between tip and ring.
1	6000A-02 900-Ohm Terminating Plug		Miniature telephone plug with a 900-ohm resistor between tip and ring.
2	6100B-02 Cord	3	Shielded two-conductor cable 3.0 metres (10 feet) long with a miniature tip-ring-sleeve telephone plug on one end and a twin banana plug on the other end; equivalent to 6000B-02.
2	6100C-02 Cord		Shielded two-conductor cable 3.0 metres (10 feet) long with a miniature tip-ring-sleeve telephone plug on each end; equivalent to 6000C-02.
1	6100D-02 Cord		Shielded two-conductor cable 3.0 metres (10 feet) long with a 310-type tip-ring-sleeve telephone plug on one end and a miniature tip-ring-sleeve telephone plug on the other end; equivalent to 6000D-02.
24	141-54484-01 Open Plug		Dummy (plastic) miniature telephone plug.

NOTES:

1. 91249-02 Channel Unit Extender is required with the following channel units:
   - 91243
   - 91250
   - 91253-02 M2
2. 91256 Test Level Adapter is required with model 1 of the following channel units:
   - 91252-01, -02
   - 91253
   - 91254
   - 91255
   - 91257
   - 91258
   - 91259
3. Furnished with 91232 Test and Alignment Set.
4. One 600-ohm terminating plug is required for each 91241-04 channel unit; one 900-ohm terminating plug is required for each 91241-02 or 91245-01 channel unit. Maximum quantity recommended is 24.
5. GTEP Section 032-201-150 gives a complete listing and description of GTE Lenkurt test cords, plugs, and adapters.

Figure 5-2. 91249 Channel Unit Extender

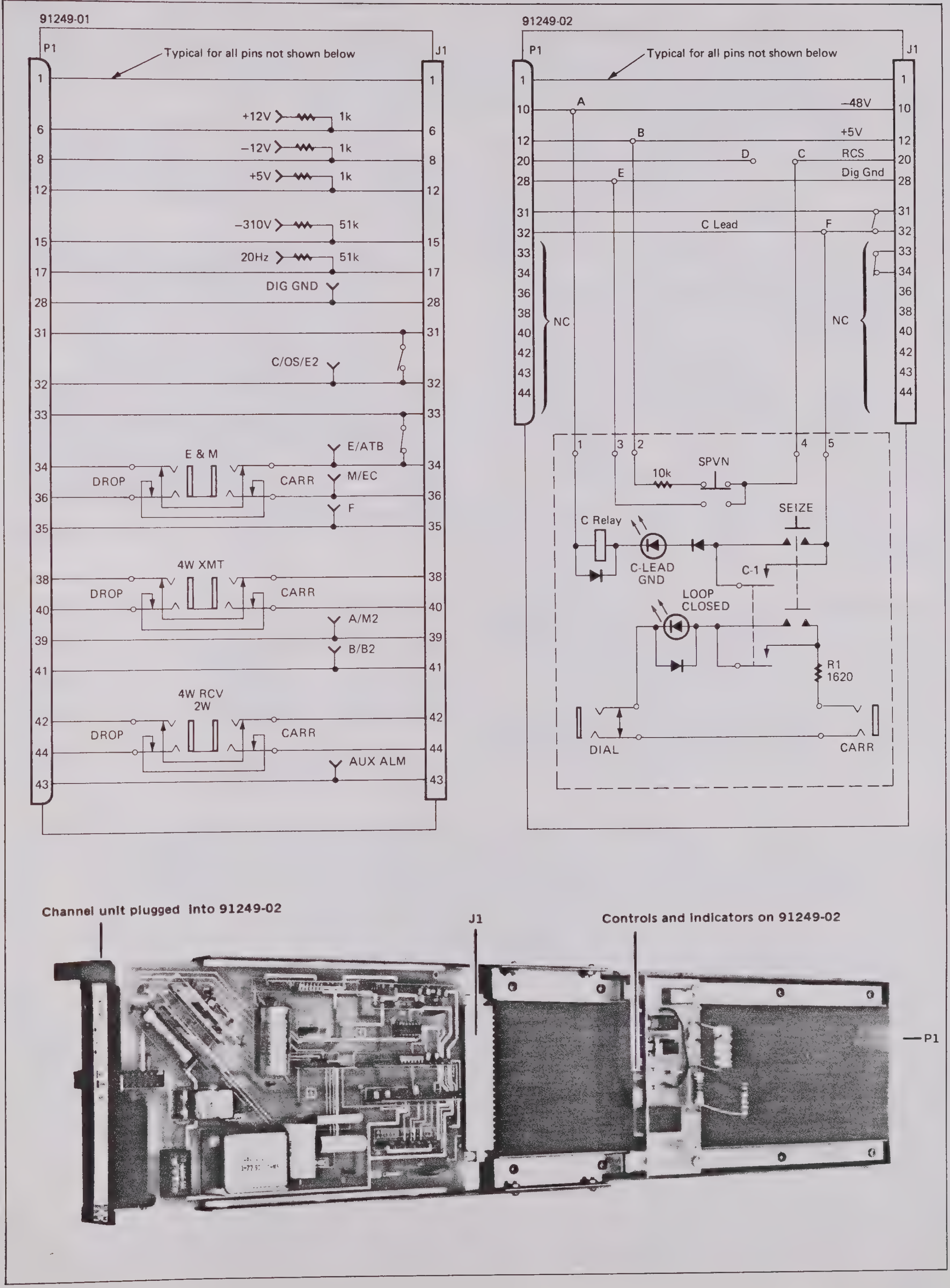
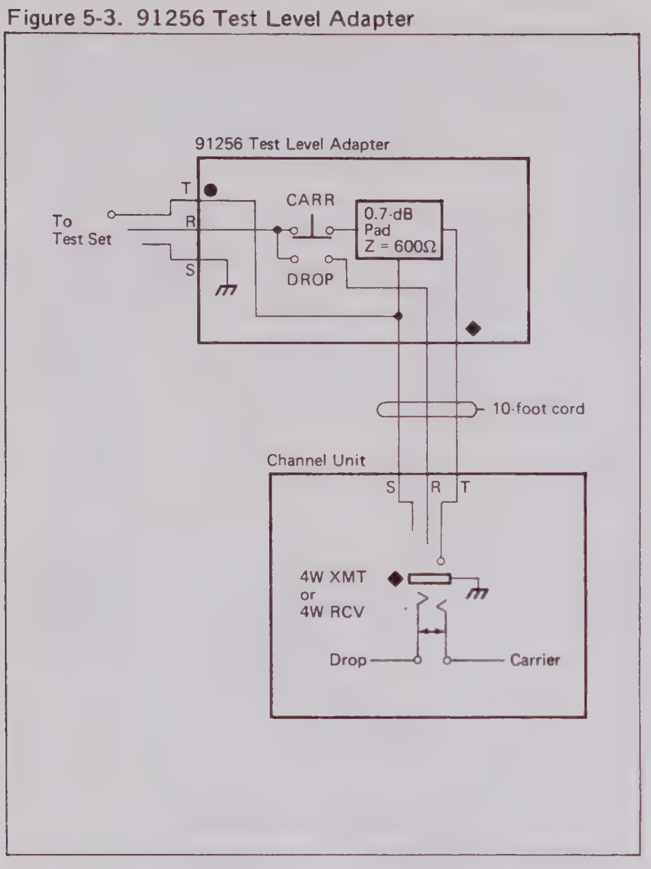

91249-01
P1
J1
Typical for all pins not shown below
1
6
8
12
15
17
28
31
32
33
34
36
35
38
40
39
41
42
44
43
+12V
1k
−12V
1k
+5V
1k
−310V
51k
20Hz
51k
DIG GND
C/OS/E2
E & M
DROP
CARR
E/ATB
M/EC
F
4W XMT
DROP
CARR
A/M2
B/B2
4W RCV
2W
DROP
CARR
AUX ALM
91249-02
P1
J1
Typical for all pins not shown below
A
−48V
B
+5V
D
C
RCS
E
Dig Gnd
C Lead
F
NC
NC
1
10
12
20
28
31
32
33
34
36
38
40
42
43
44
1
3
2
4
5
10k
SPVN
SEIZE
C Relay
C-LEAD
GND
C-1
LOOP
CLOSED
R1
1620
DIAL
CARR
Channel unit plugged into 91249-02
J1
Controls and indicators on 91249-02
P1

Figure 5-3. 91256 Test Level Adapter



6. ORDERING INFORMATION

6.01 Available channel units are listed in figure 6-1. Test equipment is listed in Part 5. Channel units and GTE Lenkurt items of test equipment may be ordered by specifying the type no. or part no., abbreviated name, and any applicable codes; for example, "91255-02 DPT Channel Unit e/w Code A." Coded items are shipped loose for field installation.

6.02 91234 Channel Unit. When the channel bank includes 91234 Four-Wire SF Channel Units, an external supply of 2600-Hz signaling tone, 5.2 volts rms (± 1 dB) at 0.9 mW per 91234 unit, is required. The two supplies listed below are part of the 11A Signaling System described in GTEP Section 342-111-110.

(a) 1189A SF Tone Supply Shelf equipped with two 1160A 2600-Hz Oscillator Units (two for redundancy) and one 1161A SF Supply Alarm Unit; maximum load is 1.1 watts, equivalent to 1224 channel units.

(b) 1188A Accessory Equipment Shelf equipped with one 1160B 2600-Hz Oscillator Unit; maximum load is 65 milliwatts, equivalent to 72 channel units.

6.03 91237, 91290, and 91291 Channel Units. The composite hybrid on the 91237, 91290, and 91291 channel units may be balanced by an external precision network or by one of the five balance networks described in figure 6-2. Installation consists of mounting the network on the channel unit by the four screws furnished; electrical connections are made through two of the screws.

Figure 6-1. List of Available Channel Units

Type No.	Model	Name	Description and Options
91234-01	1	Four-Wire SF Channel Unit	Interfaces fdm carrier channel that uses sf signaling; see paragraph 6.02 for 2600-Hz signaling tone supply required
91237-01	1	Two-Wire Duplex Channel Unit	Interfaces physical duplex signaling trunk; see paragraph 6.03 for optional hybrid balance networks.
91238-01	1	No. 2 EAX Channel Unit	Interfaces No. 2 EAX; 91330-04 shelf is required
91240-XX	1	Four-Wire E&M Channel Unit	-01 Transmit/receive levels —16/+7 dBm; type 1 E&M signaling interface -04 Transmit/receive levels —16/+7 or +7/—16 dBm; type 1 or II E&M signaling interface
91241-XX	1	Two-Wire E&M Channel Unit	-01 Impedance 900 ohms -03 Impedance 600 ohms
91242-03	1	Four-Wire Channel Unit	Vf transmission only; transmit/receive levels —16/+7 or +7/—16 dBm
91250-01	1	Stop Dial/Wink Originating Channel Unit	Interfaces ticketer or outgoing four-wire selector tied to a ticketer
91251-01	2	ETS-4 Channel Unit	Interfaces ETS-4 switching machine or TSPS trunk connected to ETS-4; 91330-03 shelf is required
91252-XX	1	Two-Wire E&M Channel Unit	-01 Impedance 900 ohms; type 1 E&M signaling interface -03 Impedance 900 ohms; type 1, II, or III E&M signaling interface -04 Impedance 900 ohms; type 1 E&M signaling interface
91253-XX	2	Dial Pulse Originating Channel Unit	-01 Interfaces three-wire SxS selector or No. 5 crossbar -02 Interfaces three or four-wire SxS selector or No. 5 crossbar
91254-XX	2	Four-Wire E&M Channel Unit	-01 Transmit/receive levels —16/+7 dBm; type 1 E&M signaling interface -02 Transmit/receive levels —16/+7 or +7/—16 dBm; type I, II, or III E&M signaling interface -04 Same as -02, except provides C-Lead option, back-to-back operation, and equipped with "busy forward".
91255-XX	2	Dial Pulse Terminating Channel Unit	-01 Basic channel unit -02 Includes level coordination pads, office loss compensation, and normalled-through four-wire jacks Code A Pulse corrector for -02 unit.
91257-01	1	Four-wire Tandem Channel Unit	Back-to-back channel unit interface; dual E&M leads for A and B signaling channels
91258-01	2	Foreign Exchange Office Channel Unit	Impedance 900/600 ohms; transmit/receive TLP —16/+7 dBm
91259-01	2	Foreign Exchange Subscriber Channel Unit	Impedance 900/600 ohms; transmit/receive TLP —16/+7 dBm
91290-01	1	Dial Pulse Originating/Incoming Trunk Channel Unit	Interfaces physical loop trunk; see paragraph 6.03 for optional hybrid balance networks; channel bank DS1 side connects to digital switch
91291-01	1	Dial Pulse Terminating/Outgoing Trunk Channel Unit	See description of 91290-01 above

Figure 6-2. Hybrid Balance Networks Used on 91237, 91290, and 91291 Channel Units

Code	Part Number	Balance Network For:
DA	087-54714-01	D66 loaded cable; high-capacitance 0.90-mm (19-gauge) or 0.63-mm (22-gauge) wire size.
HA	087-54711-01	H88 loaded cable; high-capacitance 0.90-mm (19-gauge) thru 0.50-mm (24-gauge) wire size; low capacitance 0.50-mm (24-gauge) wire size.
HB	087-54713-01	H88 loaded cable; high- or low-capacitance 0.40-mm (26-gauge) wire size.
NA [1]	087-54712-01	Nonloaded cable terminated by 900 ohms in series with 2.15μF; high-capacitance 0.90-mm (19-gauge) thru 0.40-mm (26-gauge) wire size; low capacitance 0.90-mm (19-gauge), 0.50-mm (24-gauge), and 0.40-mm (26-gauge).
OA	087-54710-02 [2]	Termination of 600 or 900 ohms in series with 2.15 μF; may include up to 1,829 m (6,000 feet) of nonloaded cable but resistance of cable plus termination cannot exceed 1,000 ohms.

NOTES:

[1] Each network except Code NA includes NBO capacitance adjustable to 0.126 μF in 0.002 μF steps.

[2] The 087-54710-02 supersedes the 087-54710-01 and is a direct replacement for it.

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GTE LENKURT

Company Headquarters and
Manufacturing Facility

1105 County Road
San Carlos, California 94070
Phone 415–595-3000

Albuquerque
Manufacturing Facility

One Camino de Lenkurt
Albuquerque, New Mexico 87123
Phone 505-296-0551

El Paso
Manufacturing Facility

10727 Gateway West
El Paso, Texas 79935
Phone 915 593-3400

District
Sales Offices

1105 County Road
San Carlos, California 94070
Phone 415 595-3000

120 West Eastman Street
Arlington Heights, Illinois 60004
Phone 312—398 6700

340 Northcrest Building
8609 Northwest Plaza Drive
Dallas, Texas 75225
Phone 214-363 0286

7950 Woodruff Court
Springfield, Virginia 22151
Phone 703—321-8560

361 E. Paces Ferry Rd., N.E.
Atlanta, Georgia 30305
Phone 404 261 8282

GTE International
Sales Office

1105 County Road
San Carlos, California 94070
Phone 415 595 3000
Cable: GENTELINT

GTE Practices
Engineering—Plant Series
GTE LENKURT

Section 342—911—109
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9002A/B PCM Channel Bank, Alignment & Testing

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1. GENERAL

1.01 This Section includes procedures for alignment, acceptance testing, routine maintenance, and troubleshooting of the 9002A and 9002B PCM Channel Banks. The information in Section 342-911-109 supersedes corresponding information in Section 342-911-103. Associated publications are listed in figure 1.

Figure 1. Associated Publications

GTE Practices Section	Title
342-911-103	9002A PCM Channel Bank
342-911-107	9002B PCM Channel Bank
342-911-108	9002A/9002B PCM Carrier Channel Units
342-911-140 thru -156	Channel units; see figure 8

2. BACKGROUND INFORMATION

2.01 Part 2 of this Section is background information that will help you in using the alignment and test procedures of Part 3 and the troubleshooting information in Part 4.

Test Equipment

2.02 For complete lineup and acceptance testing capability, the test equipment items listed in figure 2 are required. (Some items are noted as applicable only to particular channel unit types and models.) Another item may be substituted if it has suitable accuracy and fully performs the required test functions.

2.03 In alignment of the channel bank, the acvm and other test equipment (but not the signaling test set) are connected through the 91232 Test and Alignment Set to the vf jacks on the channel units. In the test set, under the control of the CHANNEL TYPE SELECT pushbuttons, a transformer provides impedance matching and isolation between the unbalanced 600-ohm test equipment and the balanced 600- or 900-ohm vf circuits. Levels can be read directly in dBm and dBrn without applying a correction factor to the meter reading. Test equipment is connected to the MEASURE jacks on the test set; these jacks are terminated internally and the rings of the jacks are grounded.

Controls and Indicators

2.04 The functions of controls and indicators on the 91230 alarm unit (figure 3) are described below.

(a) Slide-switch S3. On 91230 models 1 and 2, S3 is called LOOP SIG and has two positions: NORM and TEST. On 91230 model 3, S3 has three positions: NORM, LOOP SIG, and TMB HOLD. (A SWITCH ALERT indicator on 91230 model 3 lights when S3 is in LOOP SIG or TMB HOLD position.) The switch must be in NORM position except for two types of troubleshooting described in Part 4. The TEST or LOOP SIG position is for pulsing tests with the channel bank looped. The TMB HOLD position is used in checking the repeatered line by looping the DS1 signal at various patching locations.

(b) SYSTEM ALARM lamp (yellow). Indicates a system alarm condition. A system alarm is initiated by a power, local, or remote alarm. With the ACO relay operated, a system alarm will be maintained by the LT relay operated or by slide-switch S3 in the TMB HOLD position.

(c) ACO button and indicator. In a system alarm condition, depressing the ACO button operates the ACO relay to silence external audible alarms. The ACO indicator lights when the relay is operated.

(d) LOOP button and indicator (green). In a system alarm condition, depressing the ACO button and then the LOOP button conditions the channel bank for looped testing as follows: loops hf transmit to hf receive but transmits continuous 1's to the hf line; alters timing so that each channel transmits to and receives from another channel. The LOOP indicator lights when the channel bank is in the looped mode.

(e) REM alarm indicator (yellow). Indicates a local alarm at the remote channel bank. At the local channel bank, a remote alarm indication will be inhibited by a prior or simultaneous local alarm.

(f) LOC alarm indicator (red). Indicates loss of receive signal, an out-of-frame condition, or decoder failure in the 91222 receive unit.

(g) PWR alarm indicator (red). Indicates a blown fuse or an output voltage failure on the 91235 power supply.

Test Record

2.05 An important part of testing is keeping an accurate record of results. Records of prior performance can be very helpful in troubleshooting. Also, the accumulation of test data creates a history that can be used to evaluate long-term system performance.

2.06 The form shown in figure 4 is suggested as a means of recording data from the initial alignment and the subsequent periodic routine alignments.

Factory Repair Service

2.07 Field repair of plug-in units is not recommended. Equipment failures should be corrected by replacing the unit with a spare. Defective units should be tagged, with the problem identified where possible, and sent to GTE Lenkurt, San Carlos, Attention: Factory Service Department. Normally, units will be repaired and returned within two weeks. If spares are not available and down time is critical, this service can be accelerated or temporary replacement units can be furnished while the unit is being repaired (GTE Lenkurt's CARE program: Customer Accommodation Restoration Equipment). In any such emergency, contact a GTE Lenkurt factory service representative: (415) 595-3000 (day or night).

2.08 For equipment out of warranty, there is only a repair charge. If a temporary CARE unit is required, there is an additional handling charge. Information on units being returned for repair may be furnished informally either by mail or telephone but should include a purchase order number as well as ship-to and bill-to addresses. Details on factory repair and CARE services can be obtained from any GTE Lenkurt sales representative. For further information, GTE companies should refer to GTE Practices Section 992-600-003, "Repair and Return, GTE Lenkurt Equipment." Other GTE Lenkurt customers may obtain copies of the brochure "Factory Repair Service" (0-2631) from any GTE Lenkurt sales office.

VF Transmission Paths

2.09 The vf transmission paths of two-wire and four-wire channel units are shown in figures 5 and 6. These simplified block diagrams show bridging test points, normal-through telephone-type jacks, gains and losses, and transmission levels or level ranges in dBm at the drop. Symbols shown at the normal-through jacks identify transmission level points (TLP's) and impedances as follows:

● −16 dB transmit, +7 dB receive; 600 ohms

◆ −16.7 dB transmit, +7.7 dB receive; 600 ohms

▲ 0 dB transmit; 600 ohms
3dBm R

■ 0 dB transmit; 900 ohms
3dBm REC.

3. ALIGNMENT AND TEST

3.01 Part 3 of this Section has 12 alignment and test procedures. Four are done with the channel bank in the looped mode and do not depend on the span line between terminals being operational. The other eight are end-to-end procedures.

3.02 Figure 7 lists the procedures and notes their applicability to channel bank installation, routine maintenance, and unit replacement. Procedures are to be performed in both directions of transmission.

3.03 For routine maintenance with the channel bank in service, the channel receive and transmit levels are adjusted and idle noise and impulse noise are measured on each channel, in turn. Distortion is measured on one channel. The recommended interval for routine maintenance is 2 years.

3.04 Because of the many signaling circuit variations, the procedures for measuring dial pulse signaling distortion are in the GTEP Sections of individual channel units. Sections applicable to pulsing tests and other special channel unit procedures are listed in figure 8.

3.05 Figures 9, 10, and 11 contain information that is referenced in the alignment and test procedures, figures 12 through 23.

Alignment Sequence

3.06 Except as indicated in figure 8, all channel units have strappable or switch-selectable pads that must be set to coordinate vf drop levels with the office equipment. For the initial channel bank alignment or a channel unit replacement, set the pads before you begin the alignment procedures in Part 3.

3.07 In any alignment or testing of a channel, adjust or verify the receive level and then the transmit level. Do this first in one direction and then in the other. The other applicable procedures should follow in the sequence of figure 7, although this is not mandatory.

In-Service Testing

3.08 Channel Busy-Out. Before you remove a channel from service for testing, verify that the trunk is idle by observing the BUSY indicator or by listening at the 2W MON or RCV MON pin jacks with a headset. When the channel is idle, depress the NORM/BUSY pushbutton or set the NORM/BUSY slide switch to BUSY position. If the channel unit does not have this control, the trunk must be busied out from the test board or by some other means.

NOTE: A pcm channel that originates in a WECo DPO or SDPO channel unit can be seized only from the WECo end.

3.09 91232 Test Set. For the reasons given below, when you are doing in-service channel bank testing, make it a habit to set the DIGITAL FUNCTION switch to OFF and release the PUSH TO TEST TERMINAL button before you connect the test set to the 91230 alarm unit. Also, never depress the PUSH TO LOOP TERMINAL button during in-service testing.

3.10 Depressing the PUSH TO TEST TERMINAL button activates the digital output of the test set; an adjacent green indicator lights while the button is depressed. Unless the DIGITAL FUNCTION switch is in the OFF position, the test set will inject a coded pcm signal into the digital receive pulse stream of the channel bank. With the switch in either of the two positions used for

(Text continues on page 7.)

Figure 2. Test Equipment Recommended for Lineup and Acceptance Tests

Qty per Site	Test Equipment (GTE Lenkurt unless otherwise specified)	Notes	Description and Use
1	91232-XX Test and Alignment Set		Supplies 1025-Hz analog test tone to channel unit vf jacks; provides interface between external test equipment and channel unit vf jacks; inserts digital test signals for selected channels in the receive 1.544-Mb/s bit stream; furnishes −48V at 0.25A to external equipment. The test set may be rack-mounting or portable and the numbering of the CHANNEL POSITION thumbwheel switches may conform to the D2 or D3 channel sampling sequence as follows: -01 Rack-mounting; D2 sequence -02 Portable; D2 sequence -03 Rack-mounting; D3 sequence -04 Portable; D3 sequence Includes Alignment Cord 035-91232-01 2.7 metres (9 feet) long for interconnection with channel bank, and the following plugs and cords: 6000A-01 600-Ohm Terminating Plug 6000A-02 900-Ohm Terminating Plug 6100B-02 Cord (qty 2) 6100C-02 Cord (qty 2) 6100D-02 Cord Rack-mounted test set can serve three standard rack assemblies; cords furnished with test set are long enough to reach channel banks in adjacent bay on either side.
1	91249-01 Channel Unit Extender	1	For troubleshooting.
1	91249-02 Channel Unit Extender	1, 2	For testing.
2	91256 Test Level Adapter	1, 3	Used to connect 91232 test set to four-wire jacks on certain channel units; coordinates test tone levels and jack circuits.
1	26600 Signaling Test Set		Sends signaling pulses at selected rate and percent break; receives signaling pulses and measures percent break.
1	Northeast Electronics TTS-37B Noise Measuring Set		Noise and level measuring test set with switch-type weighting networks and hold coil; for level measurements more accurate than ±0.25 dB, use Hewlett-Packard 400EL ACVM, or equivalent.
1	Northeast Electronics TTS-58A (or TTS-58A-CN) Impulse Noise Counter		Counts number of impulses exceeding a selected level over a selected time interval.
1	Hewlett-Packard 204C Oscillator	4	For frequency response tests, 200 to 3400 Hz at 0 dBm.
1	Simpson 260-6 Volt-Ohm-Milliammeter		General purpose multimeter with 20,000-ohms/volt sensitivity.
1	725A Cord		Two-conductor cable 3.6 metres (12 feet) long wired between tip and sleeve of two 310-type tip-ring-sleeve telephone plugs; used to supply −48V power to 26600, TTS-37B, and TTS-58A.
1	729A Cord		Shielded two-conductor cable 2.4 metres (8 feet) long with a twin pin plug on one end and a 310-type tip-ring-sleeve telephone plug on the other end; for connecting to channel unit pin jacks.
1	729B Cord		Shielded two-conductor cable 2.4 metres (8 feet) long with a twin pin plug on one end and a miniature tip-ring-sleeve telephone plug on the other end; for connecting to channel unit pin jacks.
1	6000A-01 600-Ohm Terminating Plug	5,6	Miniature telephone plug with a 600-ohm resistor between tip and ring.
1	6000A-02 900-Ohm Terminating Plug		Miniature telephone plug with a 900-ohm resistor between tip and ring.
2	6100B-02 Cord	5	Shielded two-conductor cable 3.0 metres (10 feet) long with a miniature tip-ring-sleeve telephone plug on one end and a twin banana plug on the other end; equivalent to 6000B-02.
2	6100C-02 Cord		Shielded two-conductor cable 3.0 metres (10 feet) long with a miniature tip-ring-sleeve telephone plug on each end; equivalent to 6000C-02.
1	6100D-02 Cord		Shielded two-conductor cable 3.0 metres (10 feet) long with a 310-type tip-ring-sleeve telephone plug on one end and a miniature tip-ring-sleeve telephone plug on the other end; equivalent to 6000D-02.
24	141-54484-01 Open Plug		Dummy (plastic) miniature telephone plug.

NOTES:

1. Refer to GTEP Section 342-911-108 for description and circuit diagram.
2. 91249-02 Channel Unit Extender is required with the following channel units:
   - 91243
   - 91250
   - 91253-02 M2
3. 91256 Test Level Adapter is required with model 1 of the following channel units:
   - 91252-01, -02
   - 91253
   - 91254
   - 91255
   - 91257
   - 91258
   - 91259
4. Frequency response tests are not applicable to all channel unit types; refer to figure 7.
5. Furnished with 91232 Test and Alignment Set.
6. One 600-ohm terminating plug is required for each 91241-04 channel unit; one 900-ohm terminating plug is required for each 91241-02 or 91245-01 channel unit. Maximum quantity recommended is 24.
7. GTEP Section 032-201-150 gives a complete listing and description of GTE Lenkurt test cords, plugs, and adapters.

Figure 3. 91230 Alarm Unit

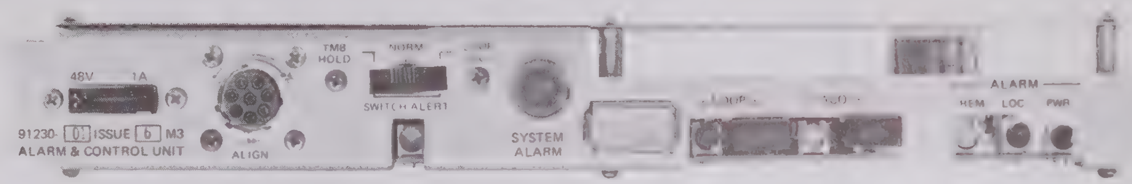


Figure 4. Sample Test Record Form

Test	Notes	Requirements			Channel No. and Reading at Initial Alignment	Routine Test Period _____ Months					
						Date By	Date By	Date By	Date By	Date By	Date By
Vf levels	1	–									
Idle noise	2,6,7	23 dBrnc0 maximum									
Distortion	4	TRANSMIT ATTENUATOR switch position	0 dB	57 or 47 dBrnc max							
			A (–20 dB)	37 or 27 dBrnc max							
			B (–34 dB)	29 or 19 dBrnc max							
Crosstalk	5,7	25 dBrnc0 max	1st interfering channel								
			2nd interfering channel								
Dial pulse signaling distortion	3	Refer to applicable channel unit GTEP Section listed in figure 8.									

NOTES:

1. Initial applicable block to indicate that vf levels have been checked and readjusted if necessary.
2. Test all channels. Record data for one channel.
3. Test all channels. Record data for two channels.
4. Test one channel. Higher distortion level is for 90 dBrnc reference.
5. At initial alignment, test all channels and record data for one channel.
6. If the transmit channel bank is WECo type D2, requirement is 28 dBrnc0 maximum.
7. To convert dBrnc0 to meter reading in dBrnc, algebraically add the transmission level at the point of test; for example, 23 dBrnc0 is 30 dBrnc at a +7 dB TLP or 20 dBrnc at a -3 dB TLP.

Figure 5. VF Transmission Paths, Two-Wire Channel Units

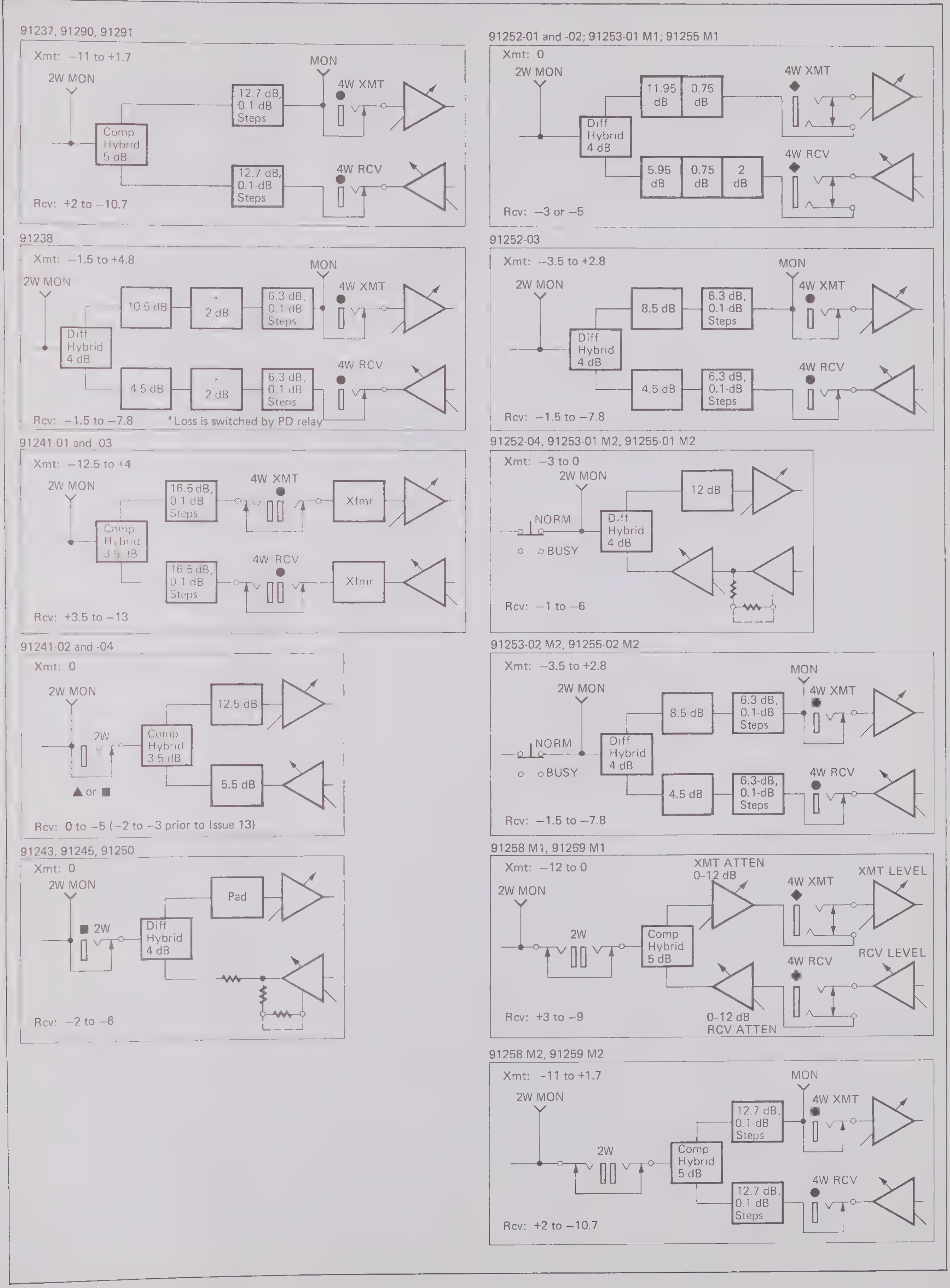
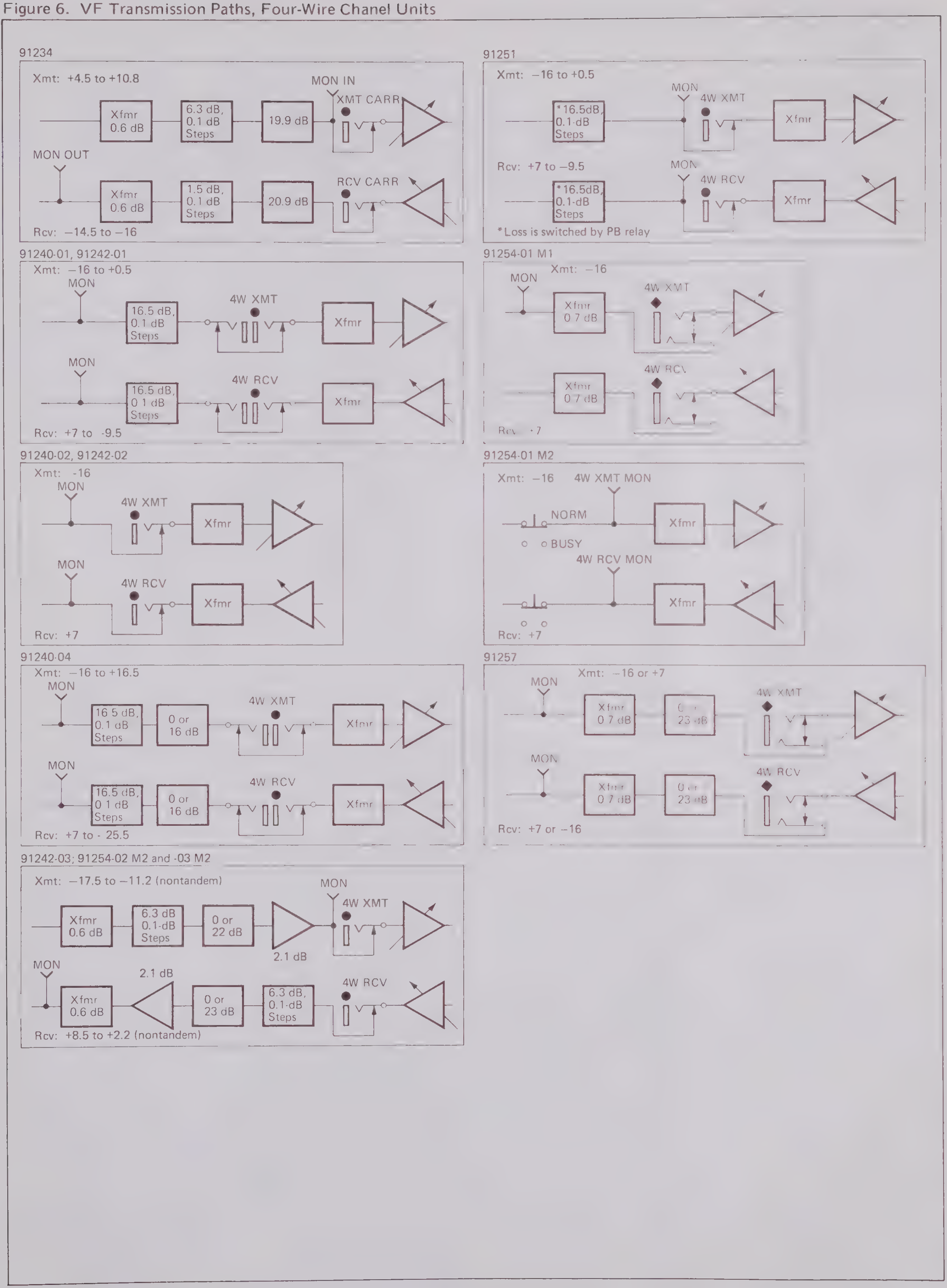

91237, 91290, 91291
Xmt: −11 to +1.7
2W MON
MON
4W XMT
12.7 dB, 0.1 dB Steps
Comp Hybrid 5 dB
12.7 dB, 0.1-dB Steps
4W RCV
Rcv: +2 to −10.7
91252-01 and -02; 91253-01 M1; 91255 M1
Xmt: 0
2W MON
4W XMT
11.95 dB
0.75 dB
Diff Hybrid 4 dB
4W RCV
5.95 dB
0.75 dB
2 dB
Rcv: −3 or −5
91238
Xmt: −1.5 to +4.8
MON
2W MON
4W XMT
10.5 dB
2 dB
6.3 dB, 0.1-dB Steps
Diff Hybrid 4 dB
4W RCV
4.5 dB
2 dB
6.3 dB, 0.1-dB Steps
Rcv: −1.5 to −7.8
*Loss is switched by PD relay
91252-03
Xmt: −3.5 to +2.8
MON
2W MON
4W XMT
8.5 dB
6.3 dB, 0.1-dB Steps
Diff Hybrid 4 dB
4W RCV
4.5 dB
6.3 dB, 0.1-dB Steps
Rcv: −1.5 to −7.8
91241-01 and -03
Xmt: −12.5 to +4
2W MON
4W XMT
16.5 dB, 0.1 dB Steps
Xfmr
Comp Hybrid 3.5 dB
4W RCV
16.5 dB, 0.1 dB Steps
Xfmr
Rcv: +3.5 to −13
91252-04, 91253-01 M2, 91255-01 M2
Xmt: −3 to 0
2W MON
12 dB
NORM
Diff Hybrid 4 dB
BUSY
Rcv: −1 to −6
91241-02 and -04
Xmt: 0
2W MON
12.5 dB
2W
Comp Hybrid 3.5 dB
5.5 dB
▲ or ■
Rcv: 0 to −5 (−2 to −3 prior to Issue 13)
91253-02 M2, 91255-02 M2
Xmt: −3.5 to +2.8
MON
2W MON
4W XMT
8.5 dB
6.3 dB, 0.1-dB Steps
NORM
Diff Hybrid 4 dB
BUSY
4W RCV
4.5 dB
6.3-dB, 0.1-dB Steps
Rcv: −1.5 to −7.8
91243, 91245, 91250
Xmt: 0
2W MON
Pad
■ 2W
Diff Hybrid 4 dB
Rcv: −2 to −6
91258 M1, 91259 M1
Xmt: −12 to 0
XMT ATTEN 0–12 dB
4W XMT
XMT LEVEL
2W MON
2W
Comp Hybrid 5 dB
4W RCV
RCV LEVEL
Rcv: +3 to −9
0–12 dB RCV ATTEN
91258 M2, 91259 M2
Xmt: -11 to +1.7
MON
2W MON
4W XMT
12.7 dB, 0.1-dB Steps
2W
Comp Hybrid 5 dB
4W RCV
12.7 dB, 0.1 dB Steps
Rcv: +2 to −10.7

Figure 6. VF Transmission Paths, Four-Wire Chanel Units


91234
Xmt: +4.5 to +10.8
MON IN
XMT CARR
Xfmr 0.6 dB
6.3 dB, 0.1 dB Steps
19.9 dB
MON OUT
Xfmr 0.6 dB
1.5 dB, 0.1 dB Steps
20.9 dB
RCV CARR
Rcv: –14.5 to –16
91251
Xmt: –16 to +0.5
MON
4W XMT
*16.5dB, 0.1-dB Steps
Xfmr
Rcv: +7 to –9.5
MON
4W RCV
*16.5dB, 0.1-dB Steps
Xfmr
*Loss is switched by PB relay
91240-01, 91242-01
Xmt: –16 to +0.5
MON
16.5 dB, 0.1 dB Steps
4W XMT
Xfmr
MON
16.5 dB, 0.1 dB Steps
4W RCV
Xfmr
Rcv: +7 to -9.5
91254-01 M1
Xmt: –16
MON
Xfmr 0.7 dB
4W XMT
Xfmr 0.7 dB
4W RCV
Rcv +7
91240-02, 91242-02
Xmt: -16
MON
4W XMT
Xfmr
MON
4W RCV
Xfmr
Rcv: +7
91254-01 M2
Xmt: –16
4W XMT MON
NORM
BUSY
Xfmr
4W RCV MON
Xfmr
Rcv: +7
91240-04
Xmt: –16 to +16.5
MON
16.5 dB, 0.1 dB Steps
0 or 16 dB
4W XMT
Xfmr
MON
16.5 dB, 0.1 dB Steps
0 or 16 dB
4W RCV
Xfmr
Rcv: +7 to - 25.5
91257
Xmt: –16 or +7
MON
Xfmr 0.7 dB
0 or 23 dB
4W XMT
MON
Xfmr 0.7 dB
0 or 23 dB
4W RCV
Rcv: +7 or –16
91242-03; 91254-02 M2 and -03 M2
Xmt: –17.5 to –11.2 (nontandem)
Xfmr 0.6 dB
6.3 dB 0.1-dB Steps
0 or 22 dB
2.1 dB
MON
4W XMT
MON
2.1 dB
Xfmr 0.6 dB
0 or 23 dB
6.3 dB, 0.1-dB Steps
4W RCV
Rcv: +8.5 to +2.2 (nontandem)

(Continued from page 2.)

in-service testing (1 kHz and QUIET on the END/END side), the receive signal on one channel will be interrupted and replaced by a 1-kHz test tone or a "quiet" signal. The affected channel will be according to the setting of the CHANNEL POSITION thumbwheel switches; see figure 9.

3.11 Because of the possibility of disrupting an in-service trunk, be sure the green indicator adjacent to the PUSH TO TEST TERMINAL button is dark during the preparations for testing. Set the DIGITAL FUNCTION switch and the CHANNEL POSITION thumbwheel switches before you depress the PUSH TO TEST TERMINAL button. Thereafter, do not change the settings without first releasing the button so that the green indicator goes dark.

NOTE: The thumbwheel switches indicate the channel number if the test set is -01 or -02 and the channel sampling sequence is D2, or if the test set is -03 or -04 and the sequence is D3. For other sequences, you must look up the required thumbwheel switch settings in figure 9.

Noise and Singing Conditions

3.12 A channel that is wired to the office equipment but is not terminated in 600 or 900 ohms, may pick up noise that will interfere with testing on other channels. Moreover, if the channel is two-wire, having the hybrid unterminated can cause singing. To prevent interference during an initial channel bank alignment, insert an open plug in the normal-through 4W XMT jack of each channel unit. Some types of channel units do not have normal-through 4W XMT jacks and require a different preventive measure as follows:

(a) 91241-02: insert a 900-ohm terminating plug (6000A-02) in the 2W jack.

(b) 91241-04: insert a 600-ohm terminating plug (6000A-01) in the 2W jack.

(c) 91243: insert an open plug in the 2W jack. The model 2 unit does not have a transmit mute circuit, but the DPT channel unit idle line termination should prevent singing; if in doubt, unplug the unit.

(d) 91245: same as (a)

(e) 91250: same as (c); the unit does not have a transmit mute circuit.

(f) 91252-04, 91253-01 M2, and 91255-01 M2: depress the NORM/BUSY pushbutton to open the two-wire drop; connect a 900-ohm, 1/2 watt resistor across the 2W MON pin jacks.

(g) 91254-01 M2: depress the NORM/BUSY pushbutton

CAUTION: Do not insert a terminating plug in the 2W CARR jack of a 91243, 91250, or 91259 channel unit. The resistor in the plug will burn out.

91256 Test Level Adapter

3.13 On some channel units, the four-wire jacks are marked with a diamond symbol (♦). The jacks are normal-through from tip to ring; the tip faces the carrier and the ring faces the drop. To access or terminate the vf circuit at a "diamond" jack, you will need a 91256 Test Level Adapter and the 91232 Test Set. Plug the adapter body into the test set and the adapter cord into the jack. Depress or release the pushbutton on the adapter for access toward the drop or carrier, respectively.

3.14 An open plug inserted in a "diamond" jack will break the vf circuit, but there may be enough leakage to affect low-level measurements downstream. It would be better to terminate the circuit by the method shown in figure 11C.

Figure 7. List of Alignment and Performance Test Procedures

Channel Bank Mode	Procedure		Recommended (x)					
	Name	Figure	Instal-lation	Routine Maint. (Note 4)	Unit Replacement (Note 5)			
					91221	91222	91230	Channel Unit
Looped	Receive level adjustment	12	x			x		
	Transmit level adjustment	13	x		x			
	Idle noise measurement	14	x		x	x		
	Distortion measurement	15	x		x	x		
End-to-end (Note 1)	System alarm restoral (Note 2)	16	x				x	
	Receive level adjustment	17		x				x
	Transmit level adjustment	18		x				x
	Idle noise measurement	19	x	x				x
	Distortion measurement	20		x				
	Frequency response (Note 3)	21	x					x
	Crosstalk measurement	22	x					
	Impulse noise measurement	23		x				
	Dial pulse signaling distortion and other tests	8	x					x

NOTES:

1. System Configuration. The end-to-end procedures in this Section are specifically for systems between 9002A and/or 9002B channel banks. However, if the equipment at one end is by another manufacturer, end-to-end operation should be satisfactory if the channel bank at each end meets the looped test requirements.

2. System Alarm Restoral. The process by which the channel banks at each end of a system restore from an alarm condition is referred to as "simultaneous restoral" or "coordinated restoral."

3. Frequency Response. Measurement is applicable only if the channel unit at either or both ends of the system has active (solid-state) vf transmit and receive filters. See figure 21 for list.

4. Routine Maintenance. The recommended interval for routine maintenance is 2 years. As part of the routine, a listening test should be made to verify absence of noise, crosstalk, etc.

5. Unit Replacement. If you replace a common equipment unit, alignment and test may be postponed unitl the system can be removed from service conveniently. Replacing a 91221 transmit unit or a 91222 receive unit probably will not change the vf receive levels more than 1/4 dB.

Figure 8. Alignment and Test Procedures in Other GTEP Sections

Channel Unit		Procedure (Note 1)			
Type	GTEP Section 342-911	VF Attenuators (Note 2)	VF Level Adjust	Pulsing Test	CPFR Test
91234 Four-Wire SF	-140	×		×	
91237 Two-Wire Duplex (Note 3)	-141	×		×	
91238 No. 2 EAX	-142	×			
91240 Four-Wire E&M	-143	-01, -04		×	
91241 Two-Wire E&M	-144	-01, -03		×	
91242 Four-Wire	-145	-01, -03			
91243 DPO Loop	-146			×	×
91245 DPT Loop	-147			×	
91250 Stop Dial/Wink Orig	-148			×	×
91251 ETS-4	-149	×		×	
91252 Two-Wire E&M	-150	-01, -02, -03	-04	×	
91253 DPO Loop	-151	-01 M1, -02 M2	-01 M2	×	-02 M2
91254 Four-Wire E&M	-152	-02 M2, -03 M2		×	
91255 DPT Loop	-153	M1, -02 M2	-01 M2	×	
91257 Four-Wire Tandem	-154			×	
91258 FXO and 91259 FXS	-155	×		×	
91290 DPO/ICT and 91291 DPT/OGT	-156	×			

NOTES:

1. Procedures. An "x" means that the procedure in the GTEP Section is applicable to all channel unit versions; otherwise it is applcable only to the dash no.'s and model no.'s listed.

2. VF Attenuators. Channel units have strappable or switch-selectable attenuators that must be set to coordinate vf drop levels with the office equipment or tandem channel units. On 91258 M1 and 91259 M1, the attenuators are operational amplifiers with variable controls.

3. 91237 Channel Unit. GTEP Section 342-911-141 also includes a DX signaling bridge balancing procedure, which is applicable for initial installation or if the channel unit is replaced.

Figure 9. Thumbwheel Switch Settings on 91232 Test Set for D3, D2, and D1D Channel Sampling Sequences

Channel Under Test	91232-01 or -02			91232-03 or -04		
	D2	D3	D1D	D3	D2	D1D
	Set CHANNEL POSITION Switches to					
1	01	12	12	01	03	01
2	02	13	01	02	15	03
3	03	01	05	03	09	05
4	04	17	09	04	21	07
5	05	05	03	05	05	09
6	06	21	07	06	17	11
7	07	09	11	07	11	13
8	08	15	02	08	23	15
9	09	03	06	09	07	17
10	10	19	10	10	19	19
11	11	07	04	11	13	21
12	12	23	08	12	01	23
13	13	11	13	13	02	02
14	14	14	17	14	14	04
15	15	02	21	15	08	06
16	16	18	15	16	20	08
17	17	06	19	17	04	10
18	18	22	23	18	16	12
19	19	10	14	19	10	14
20	20	16	18	20	22	16
21	21	04	22	21	06	18
22	22	20	16	22	18	20
23	23	08	20	23	12	22
24	24	24	24	24	24	24

Figure 10. Channel Unit Transmit-Receive Pairs with Channel Bank in Looped Mode

Channel Sampling Sequence								
D3			D2			D1D		
1	and	13	1	and	2	1	and	7
2		14	3		4	2		8
3		15	5		6	3		9
4		16	7		8	4		10
5		17	9		10	5		11
6		18	11		12	6		12
7	and	19	13	and	14	13	and	19
8		20	15		16	14		20
9		21	17		18	15		21
10		22	19		20	16		22
11		23	21		22	17		23
12		24	23		24	18		24

Figure 11. Channel Unit and Test Set Interface

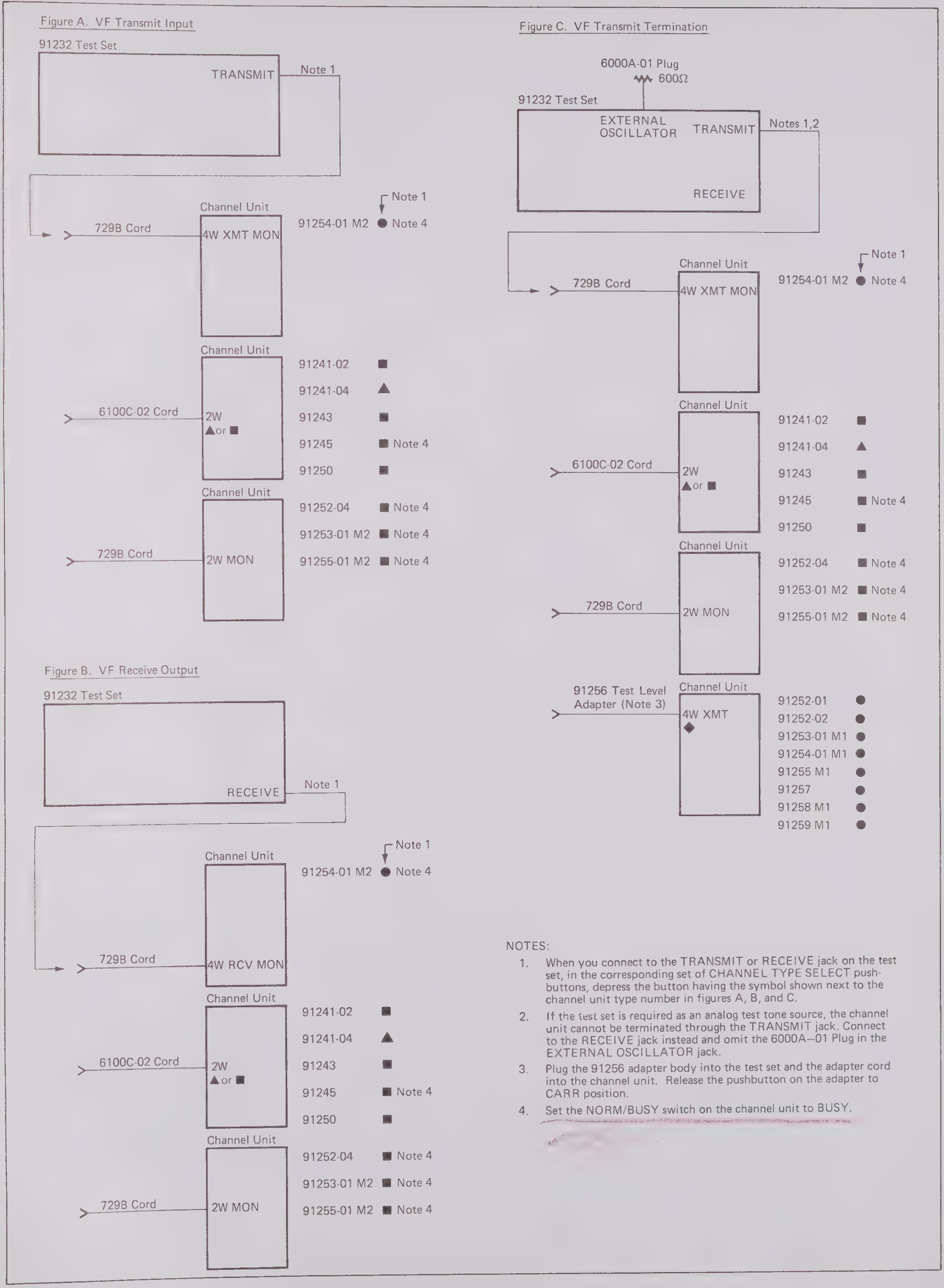


Figure A. VF Transmit Input
91232 Test Set
TRANSMIT
Note 1
Channel Unit
729B Cord
4W XMT MON
Note 1
91254-01 M2 ● Note 4
Channel Unit
91241-02 ■
91241-04 ▲
6100C-02 Cord
2W
▲or ■
91243 ■
91245 ■ Note 4
91250 ■
Channel Unit
91252-04 ■ Note 4
91253-01 M2 ■ Note 4
729B Cord
2W MON
91255-01 M2 ■ Note 4
Figure B. VF Receive Output
91232 Test Set
RECEIVE
Note 1
Channel Unit
Note 1
91254-01 M2 ● Note 4
729B Cord
4W RCV MON
Channel Unit
91241-02 ■
91241-04 ▲
6100C-02 Cord
2W
▲ or ■
91243 ■
91245 ■ Note 4
91250 ■
Channel Unit
91252-04 ■ Note 4
91253-01 M2 ■ Note 4
729B Cord
2W MON
91255-01 M2 ■ Note 4
Figure C. VF Transmit Termination
6000A-01 Plug
600Ω
91232 Test Set
EXTERNAL OSCILLATOR
TRANSMIT
Notes 1,2
RECEIVE
Channel Unit
Note 1
729B Cord
4W XMT MON
91254-01 M2 ● Note 4
Channel Unit
91241-02 ■
91241-04 ▲
6100C-02 Cord
2W
▲or ■
91243 ■
91245 ■ Note 4
91250 ■
Channel Unit
91252-04 ■ Note 4
91253-01 M2 ■ Note 4
729B Cord
2W MON
91255-01 M2 ■ Note 4
91256 Test Level Adapter (Note 3)
Channel Unit
4W XMT
◆
91252-01 ●
91252-02 ●
91253-01 M1 ●
91254-01 M1 ●
91255 M1 ●
91257 ●
91258 M1 ●
91259 M1 ●

NOTES:

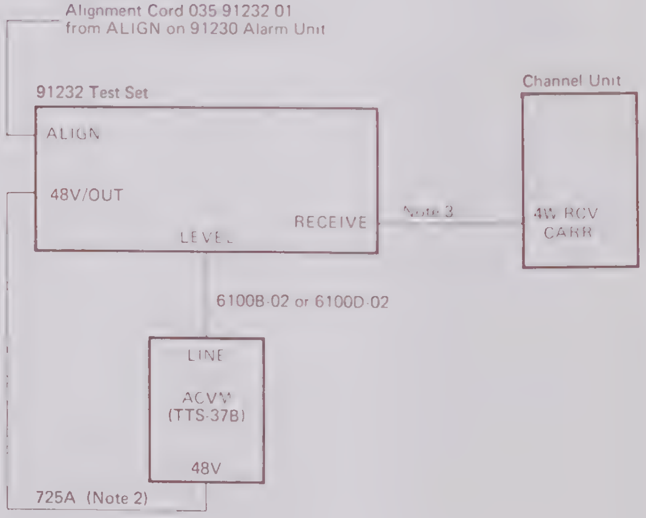
1. When you connect to the TRANSMIT or RECEIVE jack on the test set, in the corresponding set of CHANNEL TYPE SELECT pushbuttons, depress the button having the symbol shown next to the channel unit type number in figures A, B, and C.
2. If the test set is required as an analog test tone source, the channel unit cannot be terminated through the TRANSMIT jack. Connect to the RECEIVE jack instead and omit the 6000A—01 Plug in the EXTERNAL OSCILLATOR jack.
3. Plug the 91256 adapter body into the test set and the adapter cord into the channel unit. Release the pushbutton on the adapter to CARR position.
4. Set the NORM/BUSY switch on the channel unit to BUSY.

Figure 12. Channel Receive Level Adjustment, Looped Channel Bank

DESCRIPTION OF PROCEDURE:

The test set injects a coded pcm signal into the digital receive pulse stream of the channel bank. The signal is decoded in the 91222 receive unit and converted by each channel unit to an analog 1-kHz test tone at 0 dBm0. The RCV LEV control on the channel unit is adjusted with this test tone as a reference.

Step	Procedure
	NOTE: For receive level adjustment on the following channel units, refer to the applicable GTEP Section listed in figure 8: 91252-04, 91253-01 M2, and 91255-01 M2.
1	Channel Bank Loopback
	NOTE: Omit step 1 if the channel bank is already looped under test set control
1a	Set DIGITAL FUNCTION switch on test set to OFF.
1b	Release PUSH TO TEST TERMINAL button.
1c	Connect test set to 91230 alarm unit as shown in diagram.
1d	POWER ON indicator on test set should be lighted. (The model 1 test set has an integral POWER pushbutton and indicator; if the indicator is dark, momentarily depress the pushbutton.)
1e	Set DIGITAL FUNCTION switch to any position on LOOP side of switch.
	NOTE: The next step will produce a system alarm on the local and remote channel banks. On the local channel bank, the 1.544-Mb/s DS1 transmit signal will be looped to the receive branch and an all-1's signal will be transmitted to the remote channel bank where it will produce a LOC alarm indication.
1f	Momentarily depress PUSH TO LOOP TERMINAL button. The SYSTEM ALARM, LOOP, and ACO indicators on the 91230 alarm unit should light.
	NOTE: The looped mode will be maintained as long as the DIGITAL FUNCTION switch is in any of the three positions on the LOOP side of the switch (if power is on and the alignment cord is connected).
2	AC Voltmeter
2a	Set controls on acvm (TTS-37B) as follows: INPUT to 600Ω BRDG, HOLD to OFF, and FILTER to 3 KC.
2b	Connect acvm to test set as shown in diagram.
3	Digital Test Tone
3a	Set DIGITAL FUNCTION switch to 1 kHz ALL CHAN on LOOP side of switch.
3b	Depress and release 1 kHz CHECK button. Green indicator should light while button is depressed.
3c	Depress PUSH TO TEST TERMINAL button. Green indicator should light.
	NOTE: The digital output of the test set is activated when the PUSH TO TEST TERMINAL button is depressed. The resultant loss of bit 2 in the channel words will cause the REM indicator on the 91230 alarm unit to light.
4	Receive Level Adjustment
4a	Connect channel unit to RECEIVE jack on test set as shown and noted in diagram.
4b	In the RECEIVE set of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11B in the test setup, depress the button specified in figure 11B.
4c	Adjust RCV LEV control on channel unit for applicable meter reading as follows: Four-wire jack: +7.0 dBm Two-wire jack: −3.0 dBm, or as locally specified
5	End of Channel Test
5a	Disconnect test cord from channel unit.
5b	To adjust the receive level of another channel, return to step 4.
6	End of Procedure
6a	Release PUSH TO TEST TERMINAL button. Green indicator on test set and REM indicator on 91230 alarm unit should go dark.
6b	If other testing is not required, the channel bank can be removed from the looped mode by setting the DIGITAL FUNCTION switch to any position on the END/END side of the switch.



NOTES:

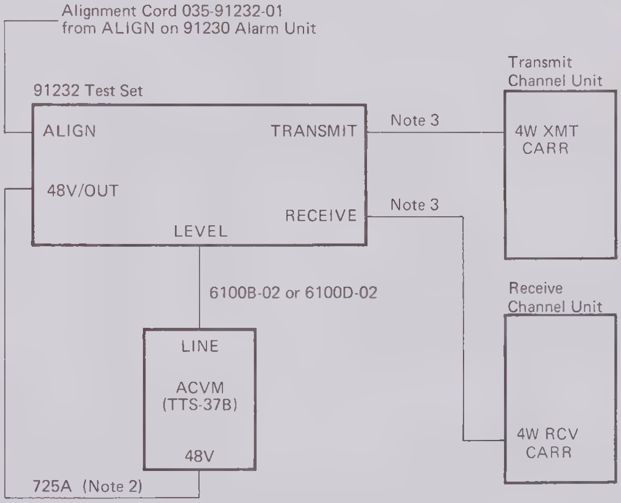
1. Test Setup. Make the connections shown in the diagram above when specified in the step-by-step procedure.
2. 48-Volt Supply. The tip of the 48V/OUT jack is connected to 48 volts through a 1-ampere fuse on the 91230 alarm unit. To prevent blowing the fuse by accidentally grounding the tip lead, plug the 725A Cord into the acvm first.
3. Channel Unit. Connect the channel unit to the test set as follows:
   - (a) If the 4W RCV jack is marked ●, connect it to the test set with a 6100C 02 Cord.
   - (b) If the 4W RCV jack is marked ◆, connect it to the test set with a 91256 Test Level Adapter. Plug the adapter body into the test set and the adapter cord into the channel unit. Release the pushbutton on the adapter to CARR position.
   - (c) If the channel unit does not have a 4W RCV jack marked ● or ◆, make the applicable connection to the test set RECEIVE jack shown in figure 11B.

Figure 13. Channel Transmit Level Adjustment, Looped Channel Bank

DESCRIPTION OF PROCEDURE:

With the channel bank looped, channel units are linked in pairs as listed in figure 10. In the procedure, a 1025-Hz analog test tone from the 91232 test set is inserted at the transmit channel unit and the level is measured at the receive channel unit. The RCV LEV control has been adjusted previously in figure 12 using a digital test tone. Now, this receive level is used as a reference for setting the XMT LEV control on the transmit channel unit.

Step	Procedure
	NOTE: For a transmit level adjustment on the following channel units, refer to the applicable GTEP Section listed in figure 8: 91252-04, 91253-01 M2, and 91255-01 M2.
1	Channel Bank Loopback
	NOTE: Omit step 1 if the channel bank is already looped under test set control.
1a	Set DIGITAL FUNCTION switch on test set to OFF.
1b	Release PUSH TO TEST TERMINAL button.
1c	Connect test set to 91230 alarm unit as shown in diagram.
1d	POWER ON indicator on test set should be lighted. (The model 1 test set has an integral POWER pushbutton and indicator; if the indicator is dark, momentarily depress the pushbutton.)
1e	Set DIGITAL FUNCTION switch to any position on LOOP side of switch.
	NOTE: The next step will produce a system alarm on the local and remote channel banks. On the local channel bank, the 1.544-Mb/s DS1 transmit signal will be looped to the receive branch and an all-1's signal will be transmitted to the remote channel bank where it will produce a LOC alarm indication.
1f	Momentarily depress PUSH TO LOOP TERMINAL button. The SYSTEM ALARM, LOOP, and ACO indicators on the 91230 alarm unit should light.
	NOTE: The looped mode will be maintained as long as the DIGITAL FUNCTION switch is in any of the three psotions on the LOOP side of the switch (if power is on and the alignment cord is connected).
2	AC Voltmeter
2a	Set controls on acvm (TTS-37B) as follows: INPUT to 600Ω BRDG, HOLD to OFF, and FILTER to 3 KC.
2b	Connect acvm to test set as shown in diagram.
3	Test Tone Calibration
3a	Set TRANSMIT ATTENUATOR switch to 0 dB.
3b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress the 2W 600Ω button (▲).
3c	While depressing 600Ω CALIBRATION pushbutton, adjust adjacent OSC LEVEL control (multiturn) for meter reading of 0.0 dBm.
3d	Release pushbutton.
4	Transmit Level Adjustment
4a	Test tone will be applied to the "transmit" channel unit. See figure 10 for the associated "receive" channel unit number.
4b	Connect channel units to TRANSMIT and RECEIVE jacks on test set as shown and noted in diagram.
4c	Release PUSH TO TEST TERMINAL button if adjacent green indicator is lighted.
4d	In the TRANSMIT and RECEIVE sets of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11A or 11B in the test setup, depress the button specified in figure 11A or 11B.
4e	Adjust XMT LEV control on transmit channel unit for applicable meter reading at receive channel unit as follows: Four-wire jack: +7.0 dBm Two-wire jack: −3.0 dBm, or as locally specified
5	End of Channel Test
5a	Disconnect test cords from channel units.
5b	To adjust the transmit level of another channel, return to step 4.
6	End of Procedure. If other testing is not required, the channel bank can be removed from the looped mode by setting the DIGITAL FUNCTION switch to any position on the END/END side of the switch.



NOTES:

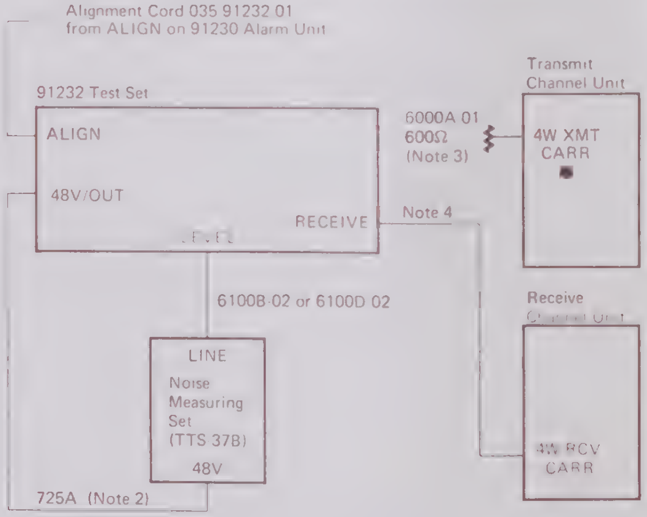
1. Test Setup. Make the connections shown in the diagram above when specified in the step-by-step procedure.
2. 48-Volt Supply. The tip of the 48V/OUT jack is connected to 48 volts through a 1-ampere fuse on the 91230 alarm unit. To prevent blowing the fuse by accidentally grounding the tip lead, plug the 725A Cord into the acvm first.
3. Channel Units. Connect the channel units to the test set as follows:
   - (a) If the 4W jack is marked ●, connect it to the test set with a 6100C-02 Cord.
   - (b) If the 4W jack is marked ◆, connect it to the test set with a 91256 Test Level Adapter. Plug the adapter body into the test set and the adapter cord into the channel unit. Release the pushbutton on the adapter to CARR position.
   - (c) If the channel unit does not have a 4W jack marked ● or ◆, make the applicable connection to the test set TRANSMIT or RECEIVE jack shown in figure 11A or 11B, respectively.

Figure 14. Idle Noise Measurement, Looped Channel Bank (Sheet 1 of 2)

DESCRIPTION OF PROCEDURE:

With the channel bank looped, channel units are linked in pairs as listed in figure 10. In the procedure, the vf input is terminated at the transmit channel unit and idle noise is measured at the vf output of the receive channel unit. As a troubleshooting aid, if the maximum acceptable noise is exceeded, a "quiet" pcm code from the 91232 test set is injected into all channels in the 91222 receive unit and noise is measured again.

Step	Procedure
1	Channel Bank Loopback NOTE: Omit step 1 if the channel bank is already looped under test set control.
1a	Set DIGITAL FUNCTION switch on test set to OFF.
1b	Release PUSH TO TEST TERMINAL button.
1c	Connect test set to 91230 alarm unit as shown in diagram.
1d	POWER ON indicator on test set should be lighted. (The model 1 test set has an integral POWER pushbutton and indicator; if the indicator is dark, momentarily depress the pushbutton.)
1e	Set DIGITAL FUNCTION switch to any position on LOOP side of switch. NOTE: The next step will produce a system alarm on the local and remote channel banks. On the local channel bank, the 1.544-Mb/s DS1 transmit signal will be looped to the receive branch and an all-1's signal will be transmitted to the remote channel bank where it will produce a LOC alarm indication.
1f	Momentarily depress PUSH TO LOOP TERMINAL button. The SYSTEM ALARM, LOOP, and ACO indicators on the 91230 alarm unit should light. NOTE: The looped mode will be maintained as long as the DIGITAL FUNCTION switch is in any of the three positions on the LOOP side of the switch (if power is on and the alignment cord is connected).
2	Noise Measuring Set
2a	Set controls on noise measuring set (TTS-37B) as follows: INPUT to 600Ω BRDG, HOLD to OFF, and FILTER to C MSG.
2b	Connect noise measuring set to test set as shown in diagram.
3	Channel Unit Setup
3a	Idle noise will be measured on the "receive" channel unit. See figure 10 for the associated "transmit" channel unit number. CAUTION: In step 3b, do not insert a terminating plug in the 2W CARR jack of a 91243, 91250, or 91259 channel unit. The resistor in the plug will burn out.
3b	Terminate transmit channel unit and connect receive channel unit to RECEIVE jack on test set as shown and noted in diagram.
3c	In the RECEIVE set of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11B in the test setup, depress the button specified in figure 11B.
4	Noise Measurement
4a	If you are measuring at a four-wire jack, the meter reading should not exceed 30 dBrnc.
4b	If you are measuring at a two-wire TLP, the maximum acceptable noise level is 23 dBrnc0. The meter reading should not exceed the algebraic sum of 23 and the dB value of the TLP; for example, 20 dBrnc at a -3 dB TLP.
5	Quiet Code NOTE: Omit step 5 if the requirements of step 4 were met.
5a	Set DIGITAL FUNCTION switch to QUIET on LOOP side of switch.
5b	Depress and release 1 kHz CHECK button. Green indicator should not light.
5c	Depress PUSH TO TEST TERMINAL button. (This activates test set digital output.) Green indicator should light.
5d	At a four-wire jack, the meter reading should not exceed 24 dBrnc.
5e	At a two-wire jack, the maximum acceptable noise level is 6 dB less than calculated for step 4b; for example, 14 dBrnc at a -3 dB TLP.
5f	Release PUSH TO TEST TERMINAL button. Green indicator should go dark.



NOTES:

1. Test Setup. Make the connections shown in the diagram above when specified in the step-by-step procedure.
2. 48-Volt Supply. The tip of the 48V/OUT jack is connected to 48 volts through a 1-ampere fuse on the 91230 alarm unit. To prevent blowing the fuse by accidentally grounding the tip lead, plug the 725A Cord into the noise measuring set first.
3. Transmit Channel Unit. If the channel unit does not have a 4W XMT jack marked ● , make the applicable termination shown in figure 11C.
4. Receive Channel Unit. Connect the channel unit to the test set as follows:
   - (a) If the 4W RCV jack is marked ● , connect it to the test set with a 6100C-02 Cord.
   - (b) If the 4W RCV jack is marked ◆, connect it to the test set with a 91256 Test Level Adapter. Plug the adapter body into the test set and the adapter cord into the channel unit. Release the pushbutton on the adapter to CARR position.
   - (c) If the channel unit does not have a 4W RCV jack marked ● or ◆ , make the applicable connection to the test set RECEIVE jack shown in figure 11B.

Figure 14. Idle Noise Measurement, Looped Channel Bank (Sheet 2 of 2)

Step	Procedure
6	End of Channel Test
6a	Disconnect test cord and terminating plug from channel units.
6b	To test another channel unit, return to step 3.
7	Troubleshooting
7a	If steps 4 and 5 fail on a particular channel, the trouble is probably in the receive channel unit. If step 4 fails but step 5 is okay, the transmit channel unit may be at fault.
7b	If steps 4 and 5 fail on all channels, the trouble is probably in the 91222 receive unit. If step 4 fails but step 5 is okay on all channels, the 91221 transmit unit should be suspected.
8	End of Procedure
8a	Release PUSH TO TEST TERMINAL button if adjacent green indicator is lighted.
8b	If other testing is not required, the channel bank can be removed from the looped mode by setting the DIGITAL FUNCTION switch to any position on the END/END side of the switch.

Figure 15. Distortion Measurement, Looped Channel Bank (Sheet 1 of 2)

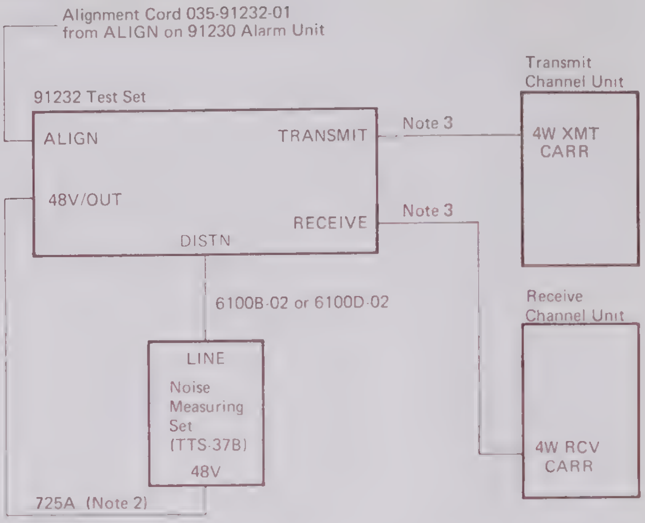
DESCRIPTION OF PROCEDURE:

With the channel bank looped, channel units are linked in pairs as listed in figure 10. In the procedure, a 1025-Hz analog test tone from the 91232 test set is inserted at the transmit channel unit and a reference level is set on the meter at the receive channel unit. Then, a 1025-Hz band elimination filter in the test set is switched into the receive measuring circuit, and the meter indicates harmonic distortion of 1025 Hz plus distortion products of 1025 Hz and the 8-kHz sampling frequency.

Step	Procedure
1	Channel Bank Loopback NOTE: Omit step 1 if the channel bank is already looped under test set control.
1a	Set DIGITAL FUNCTION switch on test set to OFF.
1b	Release PUSH TO TEST TERMINAL button.
1c	Connect test set to 91230 alarm unit as shown in diagram.
1d	POWER ON indicator on test set should be lighted. (The model 1 test set has an integral POWER pushbutton and indicator; if the indicator is dark, momentarily depress the pushbutton.)
1e	Set DIGITAL FUNCTION switch to any position on LOOP side of switch. NOTE: The next step will produce a system alarm on the local and remote channel banks. On the local channel bank, the 1.544-Mb/s DS1 transmit signal will be looped to the receive branch and an all-1's signal will be transmitted to the remote channel bank where it will produce a LOC alarm indication.
1f	Momentarily depress PUSH TO LOOP TERMINAL button. The SYSTEM ALARM, LOOP, and ACO indicators on the 91230 alarm unit should light. NOTE: The looped mode will be maintained as long as the DIGITAL FUNCTION switch is in any of the three positions on the LOOP side of the switch (if power is on and the alignment cord is connected).
2	Noise Measuring Set
2a	Set controls on noise measuring set (TTS-37B) as follows: INPUT to 600Ω BRDG, HOLD to OFF, and FILTER to C MSG.
2b	Connect noise measuring set to test set as shown in diagram. (Note that test set DISTN jack is used instead of LEVEL jack.)
3	Channel Unit Setup
3a	Test tone will be applied to the "transmit" channel unit. See figure 10 for the associated "receive" channel unit number.
3b	Connect channel units to TRANSMIT and RECEIVE jacks on test set as shown and noted in diagram.
3c	In the TRANSMIT and RECEIVE sets of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11A or 11B in the test setup, depress the button specified in figure 11A or 11B.
4	Reference Level
4a	Set TRANSMIT ATTENUATOR switch on test set to 0 dB.
4b	While depressing DISTORTION REFERENCE pushbutton, adjust adjacent control for applicable meter reading as follows: Four-wire jack: 90 dBrnc (or 80 if 90 cannot be measured) Two-wire jack: 80 dBrnc
4c	Release pushbutton.
5	Distortion Measurement
5a	With TRANSMIT ATTENUATOR switch set at 0 dB, meter reading should not exceed: 57 dBrnc if the reference is 90 47 dBrnc if the reference is 80

Figure 15. Distortion Measurement, Looped Channel Bank (Sheet 2 of 2)

Step	Procedure
5b	Set TRANSMIT ATTENUATOR switch to position A (–20 dB). Meter reading should not exceed: 37 dBrnc if the reference is 90 27 dBrnc if the reference is 80
5c	Set TRANSMIT ATTENUATOR switch to position B (–34 dB). Meter reading should not exceed: 29 dBrnc if the reference is 90 19 dBrnc if the reference is 80
6	End of Channel Test
6a	Disconnect test cords from channel units.
6b	Usually, distortion is measured on one channel only. However, if you need to test other channels, return to step 3.
7	End of Procedure. If other testing is not required, the channel bank can be removed from the looped mode by setting the DIGITAL FUNCTION switch to any position on the END/END side of the switch.



NOTES:

1. Test Setup. Make the connections shown in the diagram above when specified in the step-by-step procedure
2. 48-Volt Supply. The tip of the 48V/OUT jack is connected to 48 volts through a 1-ampere fuse on the 91230 alarm unit. To prevent blowing the fuse by accidentally grounding the tip lead, plug the 725A Cord into the noise measuring set first
3. Channel Units. Connect the channel units to the test set as follows
    - (a) If the 4W jack is marked ●, connect it to the test set with a 6100C-02 Cord.
    - (b) If the 4W jack is marked ◆, connect it to the test set with a 91256 Test Level Adapter. Plug the adapter body into the test set and the adapter cord into the channel unit. Release the pushbutton on the adapter to CARR position.
    - (c) If the channel unit does not have a 4W jack marked ● or ◆, make the applicable connection to the test set TRANSMIT or RECEIVE jack shown in figure 11A or 11B, respectively.

Figure 16. System Alarm Restoral Test

DESCRIPTION OF PROCEDURE:

With the system operating end-to-end, system alarms are initiated by looping one channel bank. Then the channel bank is unlooped and the time difference between system alarm restoral on the two channel banks is observed. The procedure verifies either of the two restoral methods ("channel 12" or "bit 2") but both channel banks must use the same method.

Step	Procedure
1	Test Setup at Each Channel Bank NOTE: If you are continuing from another procedure, some parts of step 1 will have been accomplished already.
1a	Set DIGITAL FUNCTION switch on test set to OFF.
1b	Release PUSH TO TEST TERMINAL button.
1c	Connect Alignment Cord 035-91232-01 between ALIGN connectors on test set and 91230 alarm unit.
1d	POWER ON indicator on test set should be lighted. (The model 1 test set has an integral POWER pushbutton and indicator; if the indicator is dark, momentarily depress the pushbutton.)
1e	All indicators on the 91230 alarm unit must be dark. NOTE: Designate one channel bank A and the other B.
2	Initiate System Alarm at Channel Bank A
2a	Set DIGITAL FUNCTION switch to any position on LOOP side of switch.
2b	Momentarily depress PUSH TO LOOP TERMINAL button on test set. The SYSTEM ALARM, LOOP, and ACO indicators on the 91230 alarm unit should light.
3	At Channel Bank B
3a	SYSTEM ALARM and LOC indicators should be lighted.
3b	Momentarily depress ACO button. ACO indicator should light.
4	System Alarm Restoral
4a	At channel bank A, after the system alarm condition has existed more than 15 seconds, set DIGITAL FUNCTION switch to OFF.
4b	After a delay, SYSTEM ALARM indicators on channel banks A and B should go dark within 1 second of each other. The delay depends on the model number of the 91230 alarm unit at channel bank A. Model 1 or 2: 13.5 seconds Model 3: 5 seconds
5	Test Other Direction. Repeat steps 2, 3, and 4 with the channel bank A and B designations interchanged. NOTE: If one channel bank restores about 13.5 seconds after the other, or does not restore, it may be because the channel banks are not arranged for the same restoral method.

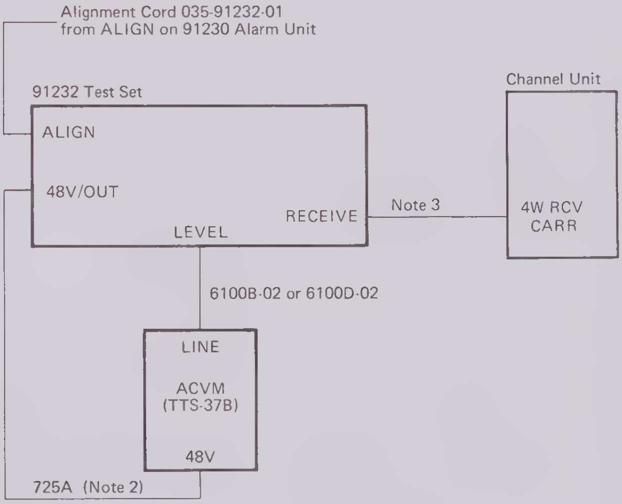
Figure 17. Channel Receive Level Adjustment, End-to-End Alignment

DESCRIPTION OF PROCEDURE:

This and other applicable end-to-end procedures enable alignment and checkout on a single-channel basis without looping the channel bank.

The test set injects a coded pcm signal into the digital receive pulse stream of the channel bank. The signal is decoded in the 91222 receive unit and converted by the channel unit to an analog 1-kHz test tone at 0 dBm0. The RCV LEV control on the channel unit is adjusted with this test tone as a reference.

Step	Procedure
	NOTE: For receive level adjustment on the following channel units, refer to the applicable GTEP Section listed in figure 8: 91252-04, 91253-01 M2, and 91255-01 M2.
1	Test Setup
	NOTE: Omit step 1 if you are continuing from another end-to-end test.
1a	Set DIGITAL FUNCTION switch on test set to OFF.
1b	Release PUSH TO TEST TERMINAL button.
1c	Connect test set to 91230 alarm unit as shown in diagram.
1d	POWER ON indicator on test set should be lighted. (The model 1 test set has an integral POWER pushbutton and indicator; if the indicator is dark, momentarily depress the pushbutton.)
2	AC Voltmeter
2a	Set controls on acvm (TTS-37B) as follows: INPUT to 600Ω BRDG, HOLD to OFF, and FILTER to 3 KC.
2b	Connect acvm to test set as shown in diagram.
3	Digital Test Tone Check
3a	Set DIGITAL FUNCTION switch to 1 kHz on END/END side of switch.
3b	Depress and release 1 kHz CHECK button. Green indicator should light while button is depressed.
4	Channel Unit Setup
4a	Connect channel unit to RECEIVE jack on test set as shown and noted in diagram.
4b	In the RECEIVE set of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11B in the test setup, depress the button specified in figure 11B.
4c	Set CHANNEL POSITION thumbwheel switches to number corresponding to channel under test according to the channel sampling sequence; see figure 9.
5	Receive Level Adjustment
5a	Depress PUSH TO TEST TERMINAL pushbutton. (This activates test set digital output.) Green indicator should light.
	NOTE: If the channel bank is in service, do not change the setting of the DIGITAL FUNCTION switch or the CHANNEL POSITION thumbwheel switches while the green indicator is lighted.)
5b	Adjust RCV LEV control on channel unit for applicable meter reading as follows: Four-wire jack: +7.0 dBm Two-wire jack: -3.0 dBm, or as locally specified
5c	Release PUSH TO TEST TERMINAL button. Green indicator should go dark.
	NOTE: If the transmit level at the far channel bank is to be adjusted, retain the test setup at the near channel bank and go to figure 18.
6	End of Channel Test
6a	Disconnect test cord from channel unit.
6b	If applicable, restore NORM/BUSY switch on channel unit to NORM.
6c	To set the receive level of another channel, return to step 4.
7	End of Procedure. If other testing is not required, set DIGITAL FUNCTION switch to OFF and disconnect test setup.



NOTES:

1. Test Setup. Make the connections shown in the diagram above when specified in the step-by-step procedure.
2. 48-Volt Supply. The tip of the 48V/OUT jack is connected to 48 volts through a 1-ampere fuse on the 91230 alarm unit. To prevent blowing the fuse by accidentally grounding the tip lead, plug the 725A Cord into the acvm first.
3. Channel Unit. Connect the channel unit to the test set as follows:
   - (a) If the 4W RCV jack is marked ●, connect it to the test set with a 6100C-02 Cord.
   - (b) If the 4W RCV jack is marked ◆, connect it to the test set with a 91256 Test Level Adapter. Plug the adapter body into the test set and the adapter cord into the channel unit. Release the pushbutton on the adapter to CARR position.
   - (c) If the channel unit does not have a 4W RCV jack marked ● or ◆, make the applicable connection to the test set RECEIVE jack shown in figure 11B.

Figure 19. Idle Noise Measurement, End-to-End Alignment (Sheet 2 of 2)

Step	Procedure
6	Quiet Code at Receive Channel Bank
	NOTE: Omit step 6 if the requirements of step 5 were met.
6a	Set DIGITAL FUNCTION switch to QUIET on END/END side of switch.
6b	Momentarily depress 1 kHz CHECK button. Green indicator should not light.
6c	Set CHANNEL POSITION thumbwheel switches to number corresponding to channel under test according to channel sampling sequence; see figure 9.
6d	Depress PUSH TO TEST TERMINAL button. (This activates test set digital output.) Green indicator should light.
	NOTE: If the channel bank is in service, do not change the setting of the DIGITAL FUNCTION switch or the CHANNEL POSITION thumbwheel switches while the green indicator is lighted.
6e	At a four-wire jack, meter reading should not exceed 24 dBrnc.
6f	At a two-wire jack, maximum acceptable noise level is 6 dB less than calculated for step 5b; for example, 14 dBrnc at a -3 dB TLP.
6g	Release PUSH TO TEST TERMINAL button. Green indicator should go dark.
7	End of Channel Test
7a	Disconnect test cord and terminating plug from channel units.
7b	If applicable, restore NORM/BUSY switch on channel unit to NORM.
7c	To test another channel, return to step 3.
8	Troubleshooting
8a	If steps 5 and 6 fail on a particular channel, the trouble is probably in the receive channel unit. If step 5 fails but step 6 is okay, the transmit channel unit may be at fault.
8b	If steps 5 and 6 fail on all channels, the trouble is probably in the 91222 receive unit. If step 5 fails but step 6 is okay on all channels, the 91221 transmit unit should be suspected.
9	End of Procedure
9a	Release PUSH TO TEST TERMINAL button if adjacent green indicator is lighted.
9b	If other testing is not required, set DIGITAL FUNCTION switch to OFF and disconnect test setup.

Figure 20. Distortion Measurement, End-to-End Alignment (Sheet 1 of 2)

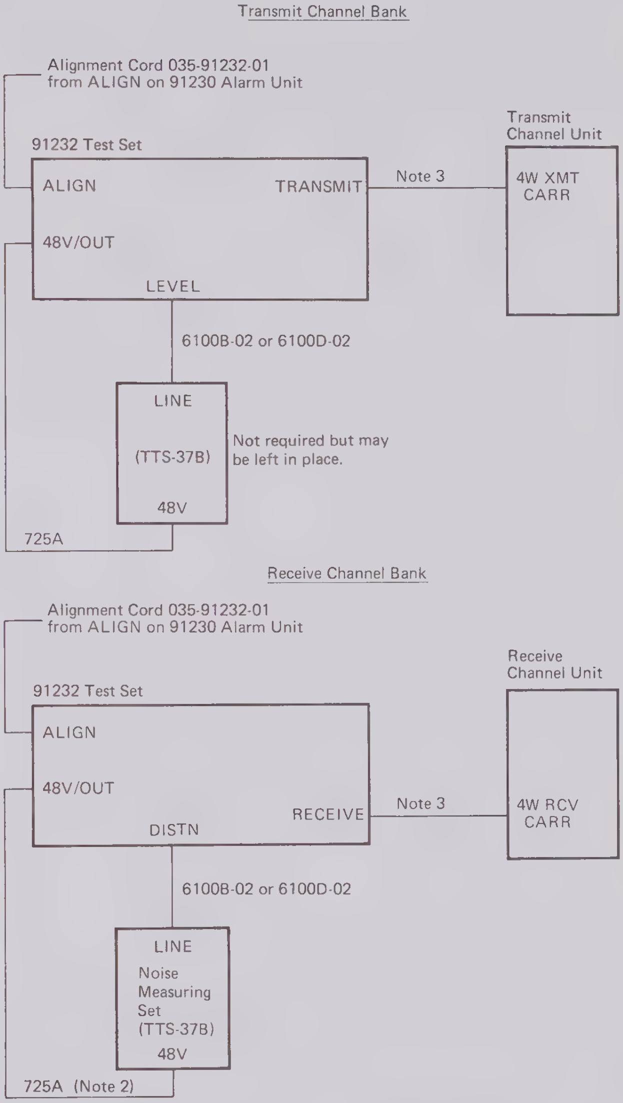
DESCRIPTION OF PROCEDURE:

A 1025-Hz analog test tone from the 91232 test set is inserted at the transmit channel unit and a reference level is set on the meter at the receive channel unit. Then, a 1025-Hz band elimination filter in the test set is switched into the receive measuring circuit, and the meter indicates harmonic distortion of 1025 Hz plus distortion products of 1025 Hz and the 8-kHz sampling frequency. Distortion is measured at three transmit levels (0, -20, and -34 dB) to check compandor linearity.

Step	Procedure
1	Test Set at Each Channel Bank
	NOTE: Omit step 1 if you are continuing from another end-to-end test.
1a	Set DIGITAL FUNCTION switch on test set to OFF.
1b	Release PUSH TO TEST TERMINAL button.
1c	Connect test set to 91230 alarm unit as shown in diagram.
1d	POWER ON indicator on test set should be lighted. (The model 1 test set has an integral POWER pushbutton and indicator; if the indicator is dark, momentarily depress the pushbutton.
2	Noise Measuring Set at Receive Channel Bank
2a	Set controls on noise measuring set (TTS-37B) as follows: INPUT to 600Ω BRDG, HOLD to OFF, and FILTER to C MSG.
2b	Connect noise measuring set to test set as shown in diagram. (Note that test set DISTN jack is used instead of LEVEL jack.)
3	Transmit Channel Unit Setup
3a	Connect channel unit to TRANSMIT jack on test set as shown and noted in diagram.
3b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11A in the test setup, depress the button specified in figure 11A.
4	Receive Channel Unit Setup
4a	Connect channel unit to RECEIVE jack on test set as shown and noted in diagram.
4b	In the RECEIVE set of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11B in the test setup, depress the button specified in figure 11B.
5	Reference Level
5a	At the transmit channel bank, set TRANSMIT ATTENUATOR switch on test set to 0 dB.
5b	At the receive channel bank, while depressing DISTORTION REFERENCE pushbutton on test set, adjust adjacent control for applicable meter reading: Four-wire jack: 90 dBrnc (or 80 if 90 cannot be measured) Two-wire jack: 80 dBrnc
5c	Release pushbutton.

Figure 20. Distortion Measurement, End-to-End Alignment (Sheet 2 of 2)

Step	Procedure
6	Distortion Measurement NOTE: The TRANSMIT ATTENUATOR switch is at the transmit channel bank; meter readings are at the receive channel bank.
6a	With TRANSMIT ATTENUATOR switch set at 0 dB, meter reading should not exceed: 57 dBrnc if the reference is 90 47 dBrnc if the reference is 80
6b	Set TRANSMIT ATTENUATOR switch to position A (-20 dB). Meter reading should not exceed: 37 dBrnc if the reference is 90 27 dBrnc if the reference is 80
6c	Set TRANSMIT ATTENUATOR switch to position B (-34 dB). Meter reading should not exceed: 29 dBrnc if the reference is 90 19 dBrnc if the reference is 80
7	End of Channel Test
7a	Disconnect test cords from channel units.
7b	If applicable, restore NORM/BUSY switch on channel unit to NORM.
7c	Usually, distortion is measured on one channel only. However, if you need to test other channels, return to step 3.
8	End of Procedure. If other testing is not required, disconnect test setup.


Transmit Channel Bank
Alignment Cord 035-91232-01 from ALIGN on 91230 Alarm Unit
91232 Test Set
ALIGN
TRANSMIT
48V/OUT
LEVEL
Note 3
Transmit Channel Unit
4W XMT CARR
6100B-02 or 6100D-02
LINE
(TTS-37B)
48V
Not required but may be left in place.
725A
Receive Channel Bank
Alignment Cord 035-91232-01 from ALIGN on 91230 Alarm Unit
91232 Test Set
ALIGN
48V/OUT
RECEIVE
DISTN
Note 3
Receive Channel Unit
4W RCV CARR
6100B-02 or 6100D-02
LINE
Noise Measuring Set
(TTS-37B)
48V
725A (Note 2)

NOTES:

1. Test Setup. Make the connections shown in the diagram above when specified in the step-by-step procedure.
2. 48-Volt Supply. The tip of the 48V/OUT jack is connected to 48 volts through a 1-ampere fuse on the 91230 alarm unit. To prevent blowing the fuse by accidentally grounding the tip lead, plug the 725A Cord into the noise measuring set first.
3. Channel Units. Connect the channel units to the test set as follows:
   - (a) If the 4W jack is marked ● , connect it to the test set with a 6100C-02 Cord.
   - (b) If the 4W jack is marked ◆ , connect it to the test set with a 91256 Test Level Adapter. Plug the adapter body into the test set and the adapter cord into the channel unit. Release the pushbutton on the adapter to CARR position.
   - (c) If the channel unit does not have a 4W jack marked ● or ◆ , make the applicable connection to the test set TRANSMIT or RECEIVE jack shown in figure 11A or 11B, respectively.

Figure 21. Channel Frequency Response, End-to-End Alignment (Sheet 1 of 2)

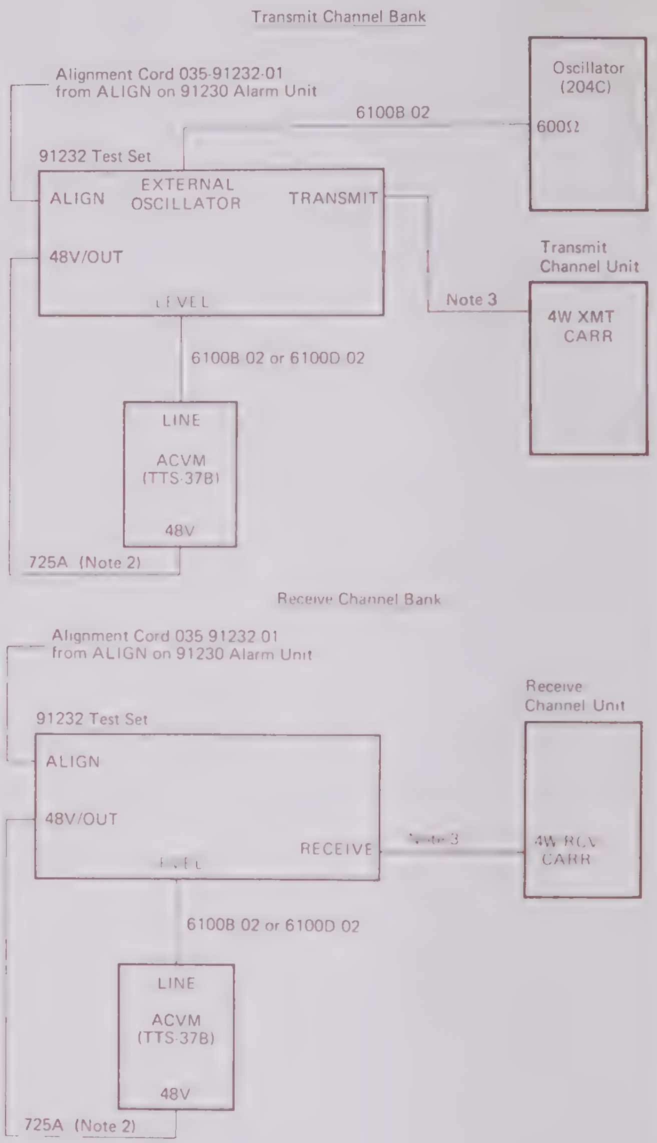
DESCRIPTION OF PROCEDURE:

Channel frequency response is measured at 200 and 3400 Hz relative to 1000 Hz. The procedure is applicable only if the channel unit at either or both ends of the system has active (solid-state) vf transmit and receive filters. These units are listed below.

91237	91255 M2
91242-03	91258 M2
91252-03 and -04	91259 M2
91253-01 M2 and -02 M2	91290
91254 M2	91291

If the test tone is inserted or measured at a two-wire jack on the channel unit, and a precision network or NBO capacitor is connected to the hybrid, the response at 3400 Hz probably will be degraded. For installation tests, response should be measured before networks or capacitors are attached, if convenient.

Step	Procedure
1	Test Set at Each Channel Bank
	NOTE: Omit step 1 if you are continuing from another end-to-end test.
1a	Set DIGITAL FUNCTION switch to OFF.
1b	Release PUSH TO TEST TERMINAL button.
1c	Connect test set to 91230 alarm unit as shown in diagram.
1d	POWER ON indicator on test set should be lighted. (The model 1 test set has an integral POWER pushbutton and indicator; if the indicator is dark, momentarily depress the pushbutton.)
2	AC Voltmeter at Each Channel Bank
2a	Set controls on acvm (TTS-37B) as follows: INPUT to 600Ω BRDG, HOLD to OFF, and FILTER to 15 KC.
2b	Connect acvm to test set as shown and noted in diagram.
3	Test Tone Calibration at Transmit Channel Bank
3a	Connect oscillator to test set as shown in diagram.
3b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress the 2W 600Ω button (▲).
3c	Set oscillator frequency at 1000 Hz.
3d	While depressing 600Ω CALIBRATION pushbutton, adjust oscillator output level for a meter reading of 0.0 dBm.
3e	Set oscillator frequency at 200 Hz. Depress 600Ω CALIBRATION pushbutton and read meter. Record the reading.
3f	Repeat step 3e at 3400 Hz.
4	Transmit Channel Unit Setup
4a	Connect channel unit to TRANSMIT jack on test set as shown and noted in diagram.
4b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11A in the test setup, depress the pushbutton specified in figure 11A.
5	Receive Channel Unit Setup
5a	Connect channel unit to RECEIVE jack on test set as shown and noted in diagram.


Transmit Channel Bank
Alignment Cord 035-91232-01 from ALIGN on 91230 Alarm Unit
6100B 02
Oscillator (204C)
600Ω
91232 Test Set
ALIGN
EXTERNAL OSCILLATOR
TRANSMIT
48V/OUT
LEVEL
Transmit Channel Unit
Note 3
4W XMT CARR
6100B 02 or 6100D 02
LINE
ACVM (TTS-37B)
48V
725A (Note 2)
Receive Channel Bank
Alignment Cord 035 91232 01 from ALIGN on 91230 Alarm Unit
Receive Channel Unit
91232 Test Set
ALIGN
48V/OUT
RECEIVE
LEVEL
Note 3
4W RCV CARR
6100B 02 or 6100D 02
LINE
ACVM (TTS-37B)
48V
725A (Note 2)

NOTES:

1. Test Setup. Make the connections shown in the diagram above when specified in the step-by-step procedure.
2. 48-Volt Supply. The tip of the 48V/OUT jack is connected to 48 volts through a 1-ampere fuse on the 91230 alarm unit. To prevent blowing the fuse by accidentally grounding the tip lead, plug the 725A Cord into the acvm first.
3. Channel Unit. Connect the channel unit to the test set as follows:
   - (a) If the 4W jack is marked ●, connect it to the test set with a 6100C-02 Cord.
   - (b) If the 4W jack is marked ◆, connect it to the test set with a 91256 Test Level Adapter. Plug the adapter body into the test set and the adapter cord into the channel unit. Release the pushbutton on the adapter to CARR position.
   - (c) If the channel unit does not have a 4W jack marked ● or ◆, make the applicable connection to the test set TRANSMIT or RECEIVE jack shown in figure 11A or 11B, respectively.

Figure 21. Channel Frequency Response, End-to-End Alignment (Sheet 2 of 2)

Step	Procedure
5b	In the RECEIVE set of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11B in the test setup, depress the pushbutton specified in figure 11B.
6	Reference Level at 1025 Hz
6a	Set the oscillator frequency at 1025 Hz.
6b	Adjust oscillator output for applicable level (set previously by the procedures of figures 12 and 13) at the receive channel unit as follows: Four-wire jack: +7.0 dBm Two-wire jack: -3.0 dBm, or as locally specified
7	Frequency Response
7a	Set oscillator frequency at 200 Hz and record meter reading at the receive channel unit. To correct for oscillator response, algebraically subtract the 200-Hz level recorded in step 3 from the reading in this step; for example, +5.5 – (-0.2) = +5.7.
7b	Repeat step 7a at 3400 Hz.
7c	Based on the corrected readings of steps 7a and 7b, the frequency response at 200 Hz and 3400 Hz relative to 1000 Hz should be 0 to -3 dB. NOTE: If the test tone is inserted and/or measured at a two-wire jack the requirement at 200 Hz is 0 to -5 dB.
8	End of Channel Test
8a	Disconnect test cords from channel units.
8b	If applicable, restore NORM/BUSY switch on channel unit to NORM.
8c	To check the frequency response of another channel, return to step 4.
9	End of Procedure. If other testing is not required, disconnect test setup.

Figure 22. Crosstalk Measurement, End-to-End Alignment (Sheet 1 of 2)

DESCRIPTION OF PROCEDURE:

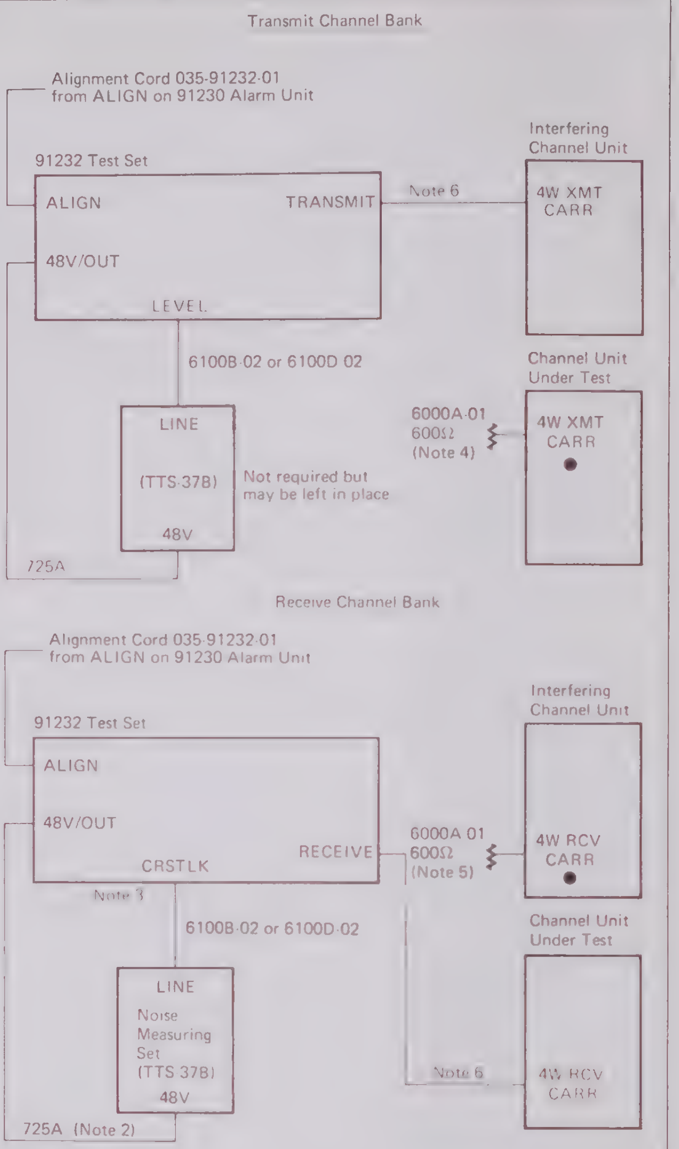
Crosstalk can take place in the PAM sampling circuits of the transmit common equipment. For each channel, there are two most likely interfering channels, related according to the sampling sequence (D3, D2, or D1D) as listed in the table on sheet 2. In the 9002A or 9002B channel bank, crosstalk into the channel under test is from the channel that precedes in the sampling sequence and the channel that follows. In the WECo channel bank, the crosstalk is from the two channels that precede.

To detect crosstalk, the vf output level of the channel under test is measured at the receive channel bank while a 1025-Hz analog test tone is inserted in the two interfering channels, one at a time, at the transmit channel bank.

Step	Procedure
1	Test Set at Each Channel Bank NOTE: Omit step 1 if you are continuing from another end-to-end test.
1a	Set DIGITAL FUNCTION switch on test set to OFF.
1b	Release PUSH TO TEST TERMINAL button.
1c	Connect test set to 91230 alarm unit as shown in diagram.
1d	POWER ON indicator on test set should be lighted. (The model 1 test set has an integral POWER pushbutton and indicator; if the indicator is dark, momentarily depress the pushbutton.)
2	Noise Measuring Set at Receive Channel Bank
2a	Set controls on noise measuring set (TTS-37B) as follows: INPUT to 600Ω BRDG, HOLD to OFF, and FILTER to C MSG.
2b	Connect noise measuring set to test set as shown in diagram.
3	Test Tone Level at Transmit Channel Bank. Set TRANSMIT ATTENUATOR switch on test set to 0 dB.
4	Interfering Channels. In the table on sheet 2, look up the numbers of the two interfering channels for the channel on which crosstalk is to be measured.
5	Transmit Channel Bank
5a	Connect first interfering channel unit to TRANSMIT jack on test set as shown and noted in diagram.
5b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11A in the test setup, depress the pushbutton specified in figure 11A. CAUTION: In step 5c, do not insert a terminating plug in the 2W CARR jack of a 91243, 91250, or 91259 channel unit. The resistor in the plug will burn out.
5c	Terminate channel unit under test as shown and noted in diagram.
6	Receive Channel Bank
6a	Connect channel unit under test to RECEIVE jack on test set as shown and noted in diagram.
6b	In the RECEIVE set of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11B in the test setup, depress the pushbutton specified in figure 11B. CAUTION: In step 6c, do not insert a terminating plug in the 2W CARR jack of a 91243, 91250, or 91259 channel unit. The resistor in the plug will burn out.
6c	Terminate first interfering channel unit as shown and noted in diagram.
7	Crosstalk Measurement at Receive Channel Bank NOTE: The levels specified below are for model 2 of the 91232 test set, which has a 1025-Hz bandpass filter preceding the CRSTLK jack. If the test set is model 1, the maximum acceptable levels are 2 dB higher than specified.
7a	If you are measuring at a four-wire jack, the meter reading should not exceed 32 dBrnc.

Figure 22. Crosstalk Measurement, End-to-End Alignment (Sheet 2 of 2)

Step	Procedure
7b	If you are measuring at a two-wire TLP, the maximum acceptable level is 25 dBrnc0. The meter reading should not exceed the algebraic sum of 25 and the dB value of the TLP; for example, 22 dBrnc at a -3 dB TLP.
8	Transmit Channel Bank. Remove the connection to the first interfering channel unit and do steps 5a and 5b for the second unit.
9	Receive Channel Bank. Unterminate the first interfering channel unit and do step 6c for the second unit.
10	Crosstalk Measurement at Receive Channel Bank. Same as step 7.
11	End of Channel Test.
11a	Disconnect test cords and terminating plugs from channel units.
11b	If applicable, restore NORM/BUSY switch on channel unit to NORM.
11c	To test another channel, return to step 4.
12	Troubleshooting
12a	If the maximum acceptable crosstalk is exceeded on all channels, the 91221 transmit unit in the transmit channel bank is probably at fault.
12b	If the maximum acceptable crosstalk is exceeded on a particular channel, try replacing the interfering channel unit in the transmit channel bank.
12c	A bad channel unit transmit gate can produce severe crosstalk into all other channels.
13	End of Procedure. If other testing is not required, set DIGITAL FUNCTION switch to OFF and disconnect test setup.


Transmit Channel Bank
Alignment Cord 035-91232-01
from ALIGN on 91230 Alarm Unit
91232 Test Set
ALIGN
TRANSMIT
48V/OUT
LEVEL
Note 6
Interfering
Channel Unit
4W XMT
CARR
6100B-02 or 6100D-02
LINE
(TTS-37B)
48V
Not required but
may be left in place
6000A-01
600Ω
(Note 4)
Channel Unit
Under Test
4W XMT
CARR
725A
Receive Channel Bank
Alignment Cord 035-91232-01
from ALIGN on 91230 Alarm Unit
91232 Test Set
ALIGN
48V/OUT
RECEIVE
CRSTLK
Note 3
Interfering
Channel Unit
6000A-01
600Ω
(Note 5)
4W RCV
CARR
6100B-02 or 6100D-02
Channel Unit
Under Test
LINE
Noise
Measuring
Set
(TTS-37B)
48V
Note 6
4W RCV
CARR
725A (Note 2)

Channel Under Test	Interfering Channels					
	9002A or 9002B Channel Bank			WECo Channel Bank		
	D3	D2	D1D	D3	D2	D1D
1	24, 2	13, 17	24, 13	24, 23	13, 12	24, 12
2	1, 3	14, 18	13, 14	1, 24	14, 11	13, 1
3	2, 4	15, 19	14, 15	2, 1	15, 9	14, 2
4	3, 5	16, 20	15, 16	3, 2	16, 10	15, 3
5	4, 6	17, 21	16, 17	4, 3	17, 1	16, 4
6	5, 7	18, 22	17, 18	5, 4	18, 2	17, 5
7	6, 8	19, 23	18, 19	6, 5	19, 3	18, 6
8	7, 9	20, 24	19, 20	7, 6	20, 4	19, 7
9	8, 10	21, 15	20, 21	8, 7	21, 5	20, 8
10	9, 11	22, 16	21, 22	9, 8	22, 6	21, 9
11	10, 12	23, 14	22, 23	10, 9	23, 7	22, 10
12	11, 13	24, 13	23, 24	11, 10	24, 8	23, 11
13	12, 14	12, 1	1, 2	12, 11	12, 24	1, 24
14	13, 15	11, 2	2, 3	13, 12	11, 23	2, 13
15	14, 16	9, 3	3, 4	14, 13	9, 21	3, 14
16	15, 17	10, 4	4, 5	15, 14	10, 22	4, 15
17	16, 18	1, 5	5, 6	16, 15	1, 13	5, 16
18	17, 19	2, 6	6, 7	17, 16	2, 14	6, 17
19	18, 20	3, 7	7, 8	18, 17	3, 15	7, 18
20	19, 21	4, 8	8, 9	19, 18	4, 16	8, 19
21	20, 22	5, 9	9, 10	20, 19	5, 17	9, 20
22	21, 23	6, 10	10, 11	21, 20	6, 18	10, 21
23	22, 24	7, 11	11, 12	22, 21	7, 19	11, 22
24	23, 1	8, 12	12, 1	23, 22	8, 20	12, 23

NOTES

1. Test Setup. Make the connections shown in the diagram above when specified in the step-by-step procedure.
2. 48-Volt Supply. The tip of the 48V/OUT jack is connected to 48 volts through a 1-ampere fuse on the 91230 alarm unit. To prevent blowing the fuse by accidentally grounding the tip lead, plug the 725A Cord into the noise measuring set first.
3. Noise Measuring Set. If the 91232 test set is model 1, connect the noise measuring set to the LEVEL jack.
4. VF Transmit Termination. If the channel unit does not have a 4W XMT jack marked ● , terminate it as shown in figure 11C.
5. VF Receive Termination. If the channel unit does not have a 4W RCV jack marked ● , terminate it as shown in figure 11C except at 4W RCV MON instead of 4W XMT MON or 4W RCV instead of 4W XMT.
6. VF Transmit and Receive. Connect the channel units to the test set as follows:
   - (a) If the 4W jack is marked ● , connect it to the test set with a 6100C-02 Cord.
   - (b) If the 4W jack is marked ◆ , connect it to the test set with a 91256 Test Level Adapter. Plug the adapter body into the test set and the adapter cord into the channel unit. Release the pushbutton on the adapter to CARR position.
   - (c) If the channel unit does not have a 4W jack marked ● or ◆ , make the applicable connection to the test set TRANSMIT or RECEIVE jack shown in figure 11A or 11B, respectively.

Figure 23. Impulse Noise Measurement, End-to-End Alignment

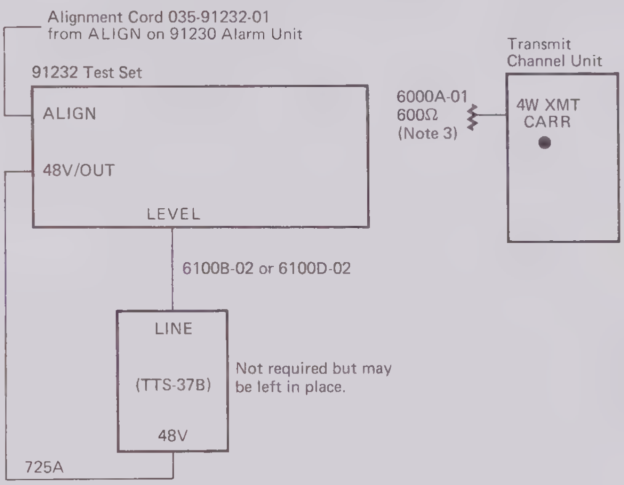
DESCRIPTION OF PROCEDURE:

On the channel under test, the vf input at the transmit channel bank is terminated (a holding tone is not required), and the vf output at the receive channel bank is connected to an impulse noise counter. Impulses that exceed a threshold level are tallied over a 5-minute period.

The test is to be conducted on an in-service system. Normal supervision may be present on the channels, but continuous dial pulsing is not allowed. The repeatered line should be essentially error free to avoid having any contribution to the readings made by impulse noise generated in the line.

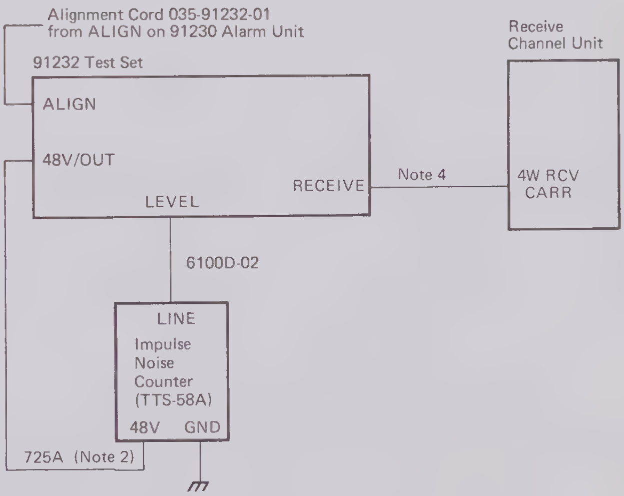
Step	Procedure
1	Test Set at Each Channel Bank
	NOTE: Omit step 1 if you are continuing from another end-to-end test.
1a	Set DIGITAL FUNCTION switch on test set to OFF.
1b	Release PUSH TO TEST TERMINAL button.
1c	Connect test set to 91230 alarm unit as shown in diagram.
1d	POWER ON indicator on test set should be lighted. (The model 1 test set has an integral POWER pushbutton and indicator; if the indicator is dark, momentarily depress the pushbutton.)
2	Impulse Noise Counter at Receive Channel Bank
2a	Set controls on impulse noise counter (TTS-58A) as follows: INPUT to 600, BRDG/TERM to BRDG, HOLD to OFF, WTG to VOICE, and POWER to ON.
2b	Connect impulse noise counter to test set as shown in diagram. Connect GND terminal to rack ground.
	CAUTION: In step 3, do not insert a terminating plug in the 2W CARR jack of a 91243, 91250, or 91259 channel unit. The resistor in the plug will burn out.
3	Transmit Channel Unit. Terminate channel unit as shown and noted in diagram.
4	Receive Channel Unit
4a	Connect channel unit to RECEIVE jack on test set as shown and noted in diagram.
4b	In the RECEIVE set of CHANNEL TYPE SELECT pushbuttons, depress the 4W 600Ω button (●). However, if you used figure 11B in the test setup, depress the button specified in figure 11B.
5	Impulse Noise Counter at Receive Channel Bank
5a	Set the HI LEVEL and MID LEVEL 2-dB step attenuator switches to 20.
5b	If you are measuring at a four-wire jack, set the REF LEVEL switches for LO LEVEL to 65 (or 66 if 65 is not available).
5c	If you are measuring at a two-wire TLP, set the REF LEVEL switches for LO LEVEL to 58 + TLP (for example, 55 at a -3 dB TLP; or 56 if 55 is not available).
6	Impulse Noise Measurement
6a	Set all counters to 0000.
6b	Turn TIME control to 5 minutes.
6c	After 5 minutes, LO LEVEL counter should not read more than 0005.
7	End of Channel Test
7a	Disconnect test cord and terminating plug from channel units.
7b	If applicable, restore NORM/BUSY switch on channel unit to NORM.
7c	To test another channel, return to step 3.
8	End of Procedure. If other testing is not required, disconnect test setup.

Transmit Channel Bank



Alignment Cord 035-91232-01 from ALIGN on 91230 Alarm Unit
91232 Test Set
ALIGN
48V/OUT
LEVEL
6000A-01 600Ω (Note 3)
Transmit Channel Unit
4W XMT CARR ●
6100B-02 or 6100D-02
LINE
(TTS-37B)
48V
Not required but may be left in place.
725A

Receive Channel Bank



Alignment Cord 035-91232-01 from ALIGN on 91230 Alarm Unit
91232 Test Set
ALIGN
48V/OUT
RECEIVE
LEVEL
Note 4
Receive Channel Unit
4W RCV CARR
6100D-02
LINE
Impulse Noise Counter (TTS-58A)
48V
GND
725A (Note 2)

NOTES:

1. Test Setup. Make the connections shown in the diagram above when specified in the step-by-step procedure.
2. 48-Volt Supply. The tip of the 48V/OUT jack is connected to 48 volts through a 1-ampere fuse on the 91230 alarm unit. To prevent blowing the fuse by accidentally grounding the tip lead, plug the 725A Cord into the impulse noise counter first.
3. Transmit Channel Unit. If the channel unit does not have a 4W XMT jack marked ●, make the applicable termination shown in figure 11C.
4. Receive Channel Unit. Connect the channel unit to the test set as follows:
   - (a) If the 4W RCV jack is marked ●, connect it to the test set with a 6100C—02 Cord.
   - (b) If the 4W RCV jack is marked ◆, connect it to the test set with a 91256 Test Level Adapter. Plug the adapter body into the test set and the adapter cord into the channel unit. Release the pushbutton on the adapter to CARR position.
   - (c) If the channel unit does not have a 4W RCV jack marked ● or ◆, make the applicable connection to the test set RECEIVE jack shown in figure 11B.

4. TROUBLESHOOTING

4.01 The primary method of troubleshooting the 9002A/B channel bank is by systematic replacement of plug-in units according to observed or measured symptoms. After a unit is replaced, test as necessary to verify normal operation. If a replacement unit does not clear the trouble, remove it and plug the original unit back into the shelf before continuing with the troubleshooting.

4.02 Field repair of plug-in units is not recommended. Defective units should be returned to GTE Lenkurt as described under Factory Repair Service in Part 2.

CAUTION: If continuity checks of the channel bank shelf wiring are required, turn off the -48V power and unplug all channel units and common equipment units. There are two reasons for this precaution. One is the possibility of damaging one or many units in the shelf by shorting adjacent pins on the shelf connectors. The other is the voltage on the multimeter leads; on the higher ohm ranges, this voltage exceeds the ratings of many integrated circuits.

Common Equipment

4.03 By analysis of alarm indications with the channel banks operating in the end-to-end and looped modes, trouble can usually be isolated to one terminal or to one direction of the repeatered line. Figure 24 is a summary of the alarm indications resulting from failure of a common equipment unit or a repeater unit. Figure 25 is a troubleshooting chart based on similar information.

Channel Units

4.04 A defective channel unit will not be detected by the channel bank alarm circuits. (An exception is mentioned below.) If improper vf transmission or signaling is evident on one channel only, isolating the defective unit is obviously not difficult. However, a shorted gate at the PAM bus or signaling bus in one channel unit may affect many or all channels. The defective unit can best be located by unplugging the channel units until the problem disappears. To ensure that other channel units are not involved, reinsert the channel units one by one, observing that the problem does not recur.

4.05 Two incidents in which trouble in one channel unit affected all channels are cited below.

(a) Through a shorted vf receive gate, the PAM bus was loaded down so that the vf receive level of all channels dropped about 6 dB.

(b) A shorted vf transmit gate clamped the PAM bus to a fixed dc voltage, forcing all bits in the channel word to logic 0. In this case, loss of bit 2 initiated a remote alarm at the distant terminal. In turn, a remote alarm was produced at the local terminal, but this cleared automatically after 15 seconds.

4.06 In another incident involving two channel units in adjacent time slots, defective gates caused excessive idle noise in all channels.

Pulsing Tests

4.07 Dial pulse signaling distortion is measured on an end-to-end basis by performance test procedures in the GTEP Sections for individual channel unit types (figure 8). The pulsing test procedure in figure 26 is for troubleshooting with the channel bank looped. Channel unit pairs (figure 10) can be tested in any of these transmit-receive combinations: E&M to E&M, E&M to DPT, DPO to DPT, and DPO to E&M. Looped tests should not be used in lieu of end-to-end tests, but only to check out the common equipment and channel unit signaling circuits.

4.08 For either end-to-end or looped testing, substituting a channel unit of the same type is a logical troubleshooting step. As an additional step, substituting an E&M type for a DPO or DPT type will make it more convenient to observe signaling malfunctions, particularly if they are marginal or intermittent.

DC Voltage Measurements

4.09 The 91235-02 model 3 Power Supply Unit has +5V, +12V, and -12V pin jack test points. With the channel bank fully equipped, voltages measured with a digital voltmeter should be within the following ranges.

(a) +5V to GND: 4.75 to 5.25

(b) +12V or -12V to GND: 11.88 to 12.12

4.10 With only the 91235-02 plugged into the channel bank, the following voltage ranges are applicable.

(a) +5V to GND: 5.0 to 6.0

(b) +12V to GND: 11.88 to 16.50

(c) -12V to GND: 11.88 to 12.12

Repeatered Line

4.11 In troubleshooting a system, the repeatered line can be checked on a sectional basis by looping the DS1 signal at various patching locations. If the go and return DS1 signal paths are good, the channel bank will come out of alarm. If the 91230 alarm unit is model 1 or 2, this would present 24 looped channels to the drop equipment. Therefore, trunks must be made busy before DSI loopback testing is undertaken.

Figure 24. Alarm Indications With Channel Bank in End-to-End and Looped Modes

Failure at Channel Bank A	91230 Alarm Unit Indicators Lighted (Note 1)			
	Channel Bank A		Channel Bank B	
	End-to End	Looped	End-to End	Looped
Power (91235 unit)	PWR	PWR	LOC	—
Encoder (91221 unit)	REM	LOC or REM	LOC	
Decoder (91222 unit)	LOC	LOC	REM	—
Repeater, A to B direction (Note 2)	REM	—	LOC	—
Repeater, both directions	LOC	—	LOC	—

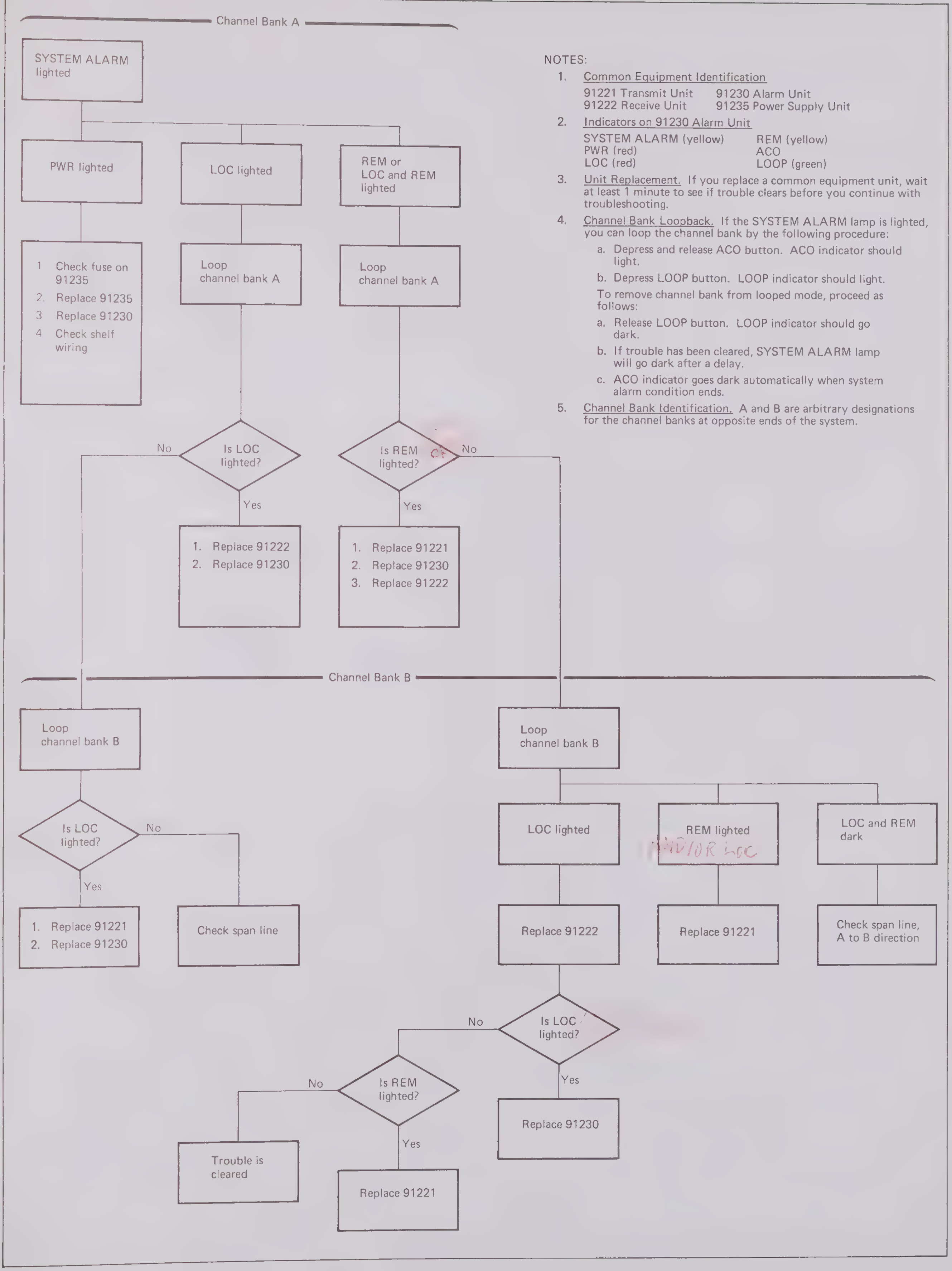
NOTES:

1. Indicators. When the LOC, REM, or PWR indicator is lighted, the SYSTEM ALARM lamp will be lighted also.

2. Repeater Failure. When the channel bank is looped, portions of the DS1 transmit and receive signal paths are not included in the loop. To verify that the trouble is not in channel bank A, loop the DS1 signal as explained in paragraphs 4.11 and 4.12.

(Text continues on page 28.)

Figure 25. Troubleshooting Chart


Channel Bank A
SYSTEM ALARM lighted
PWR lighted
LOC lighted
REM or LOC and REM lighted
1 Check fuse on 91235
2. Replace 91235
3 Replace 91230
4 Check shelf wiring
Loop channel bank A
Loop channel bank A
Is LOC lighted?
No
Yes
Is REM or lighted?
No
Yes
1. Replace 91222
2. Replace 91230
1. Replace 91221
2. Replace 91230
3. Replace 91222
Channel Bank B
Loop channel bank B
Is LOC lighted?
No
Yes
1. Replace 91221
2. Replace 91230
Check span line
Loop channel bank B
LOC lighted
REM lighted AND/OR LOC
LOC and REM dark
Replace 91222
Replace 91221
Check span line, A to B direction
Is LOC lighted?
No
Yes
Replace 91230
Is REM lighted?
No
Yes
Trouble is cleared
Replace 91221

NOTES:

1. Common Equipment Identification

91221 Transmit Unit	91230 Alarm Unit
91222 Receive Unit	91235 Power Supply Unit

2. Indicators on 91230 Alarm Unit

SYSTEM ALARM (yellow)	REM (yellow)
PWR (red)	ACO
LOC (red)	LOOP (green)

3. Unit Replacement. If you replace a common equipment unit, wait at least 1 minute to see if trouble clears before you continue with troubleshooting.
4. Channel Bank Loopback. If the SYSTEM ALARM lamp is lighted, you can loop the channel bank by the following procedure:
   a. Depress and release ACO button. ACO indicator should light.
   b. Depress LOOP button. LOOP indicator should light.

   To remove channel bank from looped mode, proceed as follows:
   a. Release LOOP button. LOOP indicator should go dark.
   b. If trouble has been cleared, SYSTEM ALARM lamp will go dark after a delay.
   c. ACO indicator goes dark automatically when system alarm condition ends.
5. Channel Bank Identification. A and B are arbitrary designations for the channel banks at opposite ends of the system.

Figure 26. Dial Pulse Signaling Distortion, Troubleshooting Test (Sheet 1 of 3)

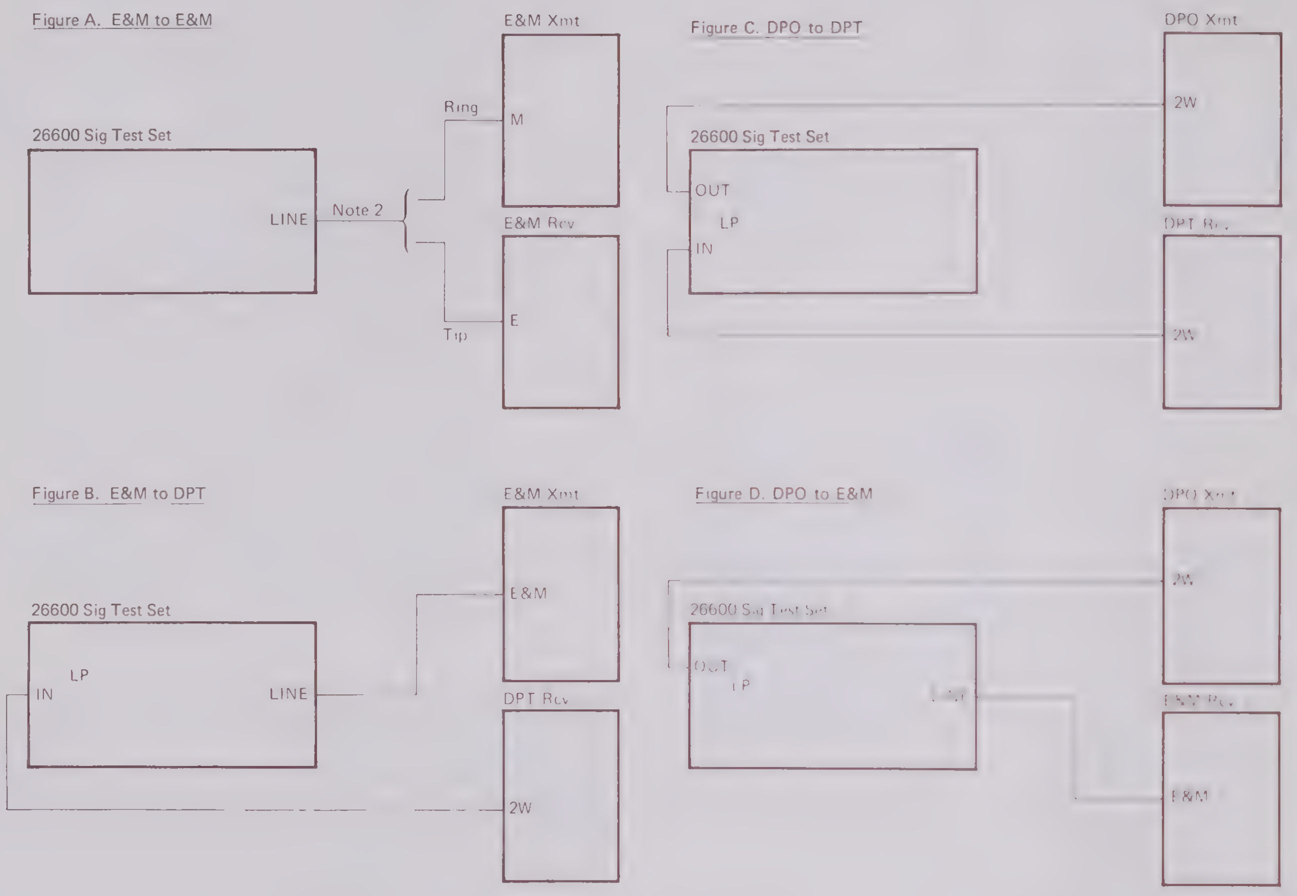


Figure A. E&M to E&M
26600 Sig Test Set
LINE
Note 2
Ring
Tip
E&M Xmt
M
E&M Rcv
E
Figure C. DPO to DPT
26600 Sig Test Set
OUT
LP
IN
DPO Xmt
2W
DPT Rcv
2W
Figure B. E&M to DPT
26600 Sig Test Set
LP
IN
LINE
E&M Xmt
E&M
DPT Rcv
2W
Figure D. DPO to E&M
26600 Sig Test Set
OUT
LP
LINE
DPO Xmt
2W
E&M Rcv
E&M

NOTES:

1. Channel Units. The following channel units require special test setups:
   - 91234: see GTEP Section 342-911-140
   - 91237: see GTEP Section 342-911-141
   - 91238: test from No. 2 EAX
   - 91257: see GTEP Section 342-911-154
2. Figure A. The test setup of figure A will have to be improvised according to the type of E&M access on the channel unit.
3. Test Cords. Connections between the test set and the channel unit depend on the type of E&M or 2W access on the channel unit. Use the 6100D-02 Cord for normal-through telephone jacks or the 729A Cord for pin jacks.
4. 729A Cord. On the twin pin plug of the 729A Cord, the tip lead is marked by an index. Connect the index to the E pin jack at E&M points or to the green (tip) pin jack at 2W points.
5. Drop Equipment. If the E&M or 2W points on the channel unit are pin jacks, the circuit to the external drop equipment must be opened by depressing the NORM/BUSY pushbutton. If the channel unit does not have a NORM/BUSY pushbutton, install the unit in a 91249-01 Extender.
6. 91255-01 M2 DPT Channel Unit. The NORM/BUSY pushbutton must be in NORM position to enable P relay operation. If the external two-wire circuit cannot be disconnected, install the channel unit in a 91249-01 Extender.
7. 91255-02 M2 DPT Channel Unit. The NORM/BUSY pushbutton must be in NORM position to check reverse battery supervision.

Figure 26. Dial Pulse Signaling, Troubleshooting Test (Sheet 2 of 3)

Step	Procedure
1	Channel Bank Loopback
	NOTE: Omit step 1 if the channel bank is already looped (LOOP indicator on the 91230 alarm unit lighted).
1a	If it is convenient to use the 91232 test set, the channel bank can be looped by the procedure in figure 12, step 1. Otherwise, continue with this procedure.
1b	If the SYSTEM ALARM indicator is not lighted, initiate an alarm by unplugging the 91222 receive unit. Then, depress the ACO button (nonlocking) and LOOP button. Plug in the 91222 receive unit.
1c	If the SYSTEM ALARM indicator is lighted but the LOOP indicator is not, depress the ACO button (nonlocking) and LOOP button.
	NOTE: In step 1d or 1e, signaling will be enabled and the TMB alarm condition will be lifted. All channel units must be made busy by setting the NORM/BUSY switch to BUSY, or by external means.
1d	If the 91230 alarm unit is model 1 or 2, set slide-switch S3 to TEST.
1e	If the 91230 alarm unit is model 3, set slide-switch S3 to LOOP SIG. The SWITCH ALERT indicator should light.
2	Channel Units
2a	Refer to figure 10 for the applicable transmit-receive channel unit pairs.
2b	E&M channel units with signaling options: strap for type I interface with open/ground on the E lead and ground/battery on the M lead.
	NOTE: Unless otherwise specified, all controls and indicators mentioned in the remainder of this procedure are on the 26600 Signaling Test Set.
3	Signaling Test Set
3a	Position the test set so that the internal mercury relay is properly oriented.
3b	Connect 48V/GRD jack to office battery with a 725A cord.
	NOTE: Do step 4, 5, 6, or 7, as applicable according to channel unit types (E&M, DPO, or DPT).
4	E&M to E&M
4a	Set all red-handled keys to center position.
4b	Set E key to O/G and M key to B/G.
4c	Set toggle switch to DIAL PULSE.
4d	Adjust SET FULL SCALE control for meter reading of 0% break.
4e	Set toggle switch to CONT PULSE.
4f	Set the ADJ % BREAK controls as follows: COARSE to center position and FINE full clockwise.
4g	While depressing PRESS TO MEASURE SPEED pushbutton, adjust ADJ SPEED control for reading of 12 pulses per second. Release pushbutton.
4h	Adjust FINE control for meter reading of 60.5% break.
4i	Because controls are interacting, repeat steps 4g and 4h.
4j	Connect test set to transmit and receive channel units as shown in figure A.
4k	Set MEASURE key to LINE.
4l	Set PULSE key to LINE. Meter should read 58.5% to 62.5% break.
4m	Set all red-handled keys to center position.
4n	To test signaling in the other direction, interchange the cords at the two channel units. (Tip and ring of the LINE jack must go to E and M, respectively.) Then, repeat steps 4k, 4l, and 4m.
5	E&M to DPT
5a	Same as steps 4a through 4i.
5b	Connect test set to transmit and receive channel units as shown in figure B.
5c	Set INCOMING key to MEASURE.
5d	Set PULSE key to LINE. Meter should read 62% to 68% break. However, refer to the DPT channel unit GTEP Section (figure 8) for more specific requirements.
5e	Set all red-handled keys to center position.
5f	Set TWD LINE key to OFF HOOK.
5g	Set INCOMING key to REVERSE. LINE indicator should go dark, indicating reverse battery supervision.
5h	Set all red-handled keys to center position.
6	DPO to DPT
6a	Refer to the DPO channel unit GTEP Section to determine the resistance applicable to the loop pulsing test.
6b	Simultaneously depress LEAK A pushbutton and the resistance pushbuttons that will add up to the value of step 6a.
6c	Set all red-handled keys to center position.
6d	Set toggle switch to DIAL PULSE.
6e	Adjust SET FULL SCALE control for meter reading of 0% break.
6f	Set toggle switch to CONT PULSE.
	NOTE: If the requirements of steps 6g thru 6j are not met, the test set may need calibration. Refer to GTEP Section 108-402-505 or to the procedure in the test set cover.
6g	Set left-hand OUTGOING key to SEND LOOP. Meter should read 68.5% break.
6h	Depress PRESS TO MEASURE SPEED pushbutton. Meter should read 12 pulses per second.
6i	Set left-hand OUTGOING key to SEND LEAK. Meter should read 60.5% break.
6j	Depress PRESS TO MEASURE SPEED pushbutton. Meter should read 12 pulses per second.
6k	Set all red-handled keys to center position.
6l	Connect test set to transmit and receive channel units as shown in figure C.
6m	Set INCOMING key to MEASURE and right-hand OUTGOING key to PULSE.
6n	Set left-hand OUTGOING key to SEND LOOP. Meter should read 78% break or less.
6o	Set left-hand OUTGOING key to SEND LEAK. Meter should read 48% break or more.
6p	Set all red-handled keys to center position.
6q	Set INCOMING key to REVERSE. SUPVN lamp should go dark, indicating reverse battery supervision.

Figure 26. Dial Pulse Signaling, Troubleshooting Test (Sheet 3 of 3)

Step	Procedure
6r	Set all red-handled keys to center position.
7	DPO to E&M
7a	Same as steps 6a thru 6k.
7b	Connect test set to transmit and receive channel units as shown in figure D.
7c	Set MEASURE key to LINE and right-hand OUTGOING key to PULSE.
7d	Set left-hand OUTGOING key to SEND LOOP. Meter should read 74% break or less.
7e	Set left-hand OUTGOING key to SEND LEAK. Meter should read 50% break or more.
7f	Set all red-handled keys to center position.
7g	Set TWD LINE key to OFF HOOK. SUPVN lamp should go dark, indicating supervision returned to the DPO channel unit.
7h	Set all red-handled keys to center position.
8	End of Test
8a	Set slide-switch S3 on the 91230 alarm unit to NORM.
8c	If you looped the channel bank with the test set, set the DIGITAL FUNCTION switch to any END/END position to restore end-to-end operation.
8d	If you looped the channel bank with the LOOP pushbutton on the 91230 alarm unit, release the button to restore end-to-end operation.

4.12 On model 3 of the 91230 alarm unit, slide-switch S3 has a special TMB HOLD position to facilitate DS1 loopback testing. In a system alarm condition, with the ACO indicator lighted, setting slide-switch S3 to TMB HOLD forces bit 2 suppression. Now, when the DS1 signal is looped back, the following indications should be observed on the channel bank.

(a) If the line is good out and back, the LOC indicator will be dark, but the REM indicator will be lighted because of bit 2 suppression.

(b) If the line is failed in either direction, the LOC indicator will be lighted. Usually, the REM indicator will be lighted too.

4.13 Other effects of having slide-switch S3 in TMB HOLD position are:

(a) The system alarm condition is maintained; SYSTEM ALARM is lighted and TMB (trunk make busy) is activated.

(b) If the channel bank is operating in the looped receive clock mode, it switches to internal clock.

(c) Vf channels are muted by a circuit in the 91222 receive unit (except 91222 M1).

GTE LENKURT

Company Headquarters and
Manufacturing Facility

1105 County Road
San Carlos, California 94070
Phone 415—595-3000

Albuquerque
Manufacturing Facility

One Camino de Lenkurt
Albuquerque, New Mexico 87123
Phone 505—296-0551

District
Sales Offices

1105 County Road
San Carlos, California 94070
Phone 415—595 3000

361 E. Paces Ferry Rd., N.E.
Atlanta, Georgia 30305
Phone 404—261-8282

120 West Eastman Street
Arlington Heights, Illinois 60004
Phone 312—398-6700

340 Northcrest Building
8609 Northwest Plaza Drive
Dallas, Texas 75225
Phone 214—363 0286

GTE Lenkurt, Inc.
7950 Woodruff Court
Springfield, Virginia 22151
Phone 703—321-8560

GTE International
Sales Office

1105 County Road
San Carlos, California 94070
Phone 415—595-3000
Cable: GENTELINT

TYPE 9002A AND 9002B PCM CHANNEL BANK EQUIPMENT COMPATIBILITY

1. GENERAL

1.01 The 9002A and 9002B channel banks are completely end-to-end compatible if "bit 2" restoral (network standard) is used at both ends of the system. This Section describes the interchangeability requirements of common equipment plug-in units and the use of modification kits to add certain new features to earlier models. Channel bank publications are listed in table 1.

1.02 Issue 2 of this Section is a complete revision of the preceding Issue 1. Changes and additions are not identified by marginal arrows.

Table 1. Associated Publications

GTEP Section	Description
342-911-103	9002A PCM Channel Bank
342-911-104	910A PCM Subscriber Carrier System
342-911-107	9002B PCM Channel Bank

2. CHANNEL BANK EQUIPMENT

2.01 Equipment shelves for the 9002A and 9002B channel banks are types 91220 and 91330, respectively. As listed in table 2, each channel bank has four plug-in common equipment units: transmit unit, receive unit, alarm unit, and power supply unit. These units have the same type numbers in each channel bank but 9002B units have later model numbers. Both channel banks use the same channel units and the same test set.

NOTE: In the text and tables of this Section, "M" stands for model.

2.02 With few exceptions, all models of the plug-in common equipment units are compatible and interchangeable. Depending on system application or the channel bank operating mode, some models may not be usable or a modification kit may need to be applied. The conditions affecting unit usability are summarized in table 3 and discussed in Parts 3 and 4.

2.03 Modification kit 91220-MK5 changes shelf wiring to enable use of either 9002A or 9002B plug-in common equipment units in the 91220 shelf. GTE Lenkurt recommends that this modification kit be applied to all 91220 shelves. The 91220-MK5 kit, with instructions and material for modifying 25 shelves, is available at no cost.

Table 2. 9002A and 9002B PCM Channel Bank Equipment List

Equipment	9002A	9002B
91220 Terminal Equipment Shelf	M1, M2, M3	
91330 Terminal Equipment Shelf		M1
91221 Transmit Common Equipment Unit	M1, M2	M3
91222 Receive Common Equipment Unit	M1, M2, M3	M4
91230 Alarm and Control Unit	M1, M2	M3
91235 Power Supply Unit	M1, M2	M3
087-53258-XX HF Line Equalizer	-01	-02
087-53259-XX HF Line Equalizer	-01	-02
Channel units 91232 Test and Alignment Set	Same for 9002A and 9002B.	

NOTE:
1. The type numbers of the power supply units are 91235-01 for M1 and M2 and 91235-02 for M3.

Table 3. 9002A/9002B Plug-in Common Equipment Unit Usability

Unit		91220 Shelf M1, M2, M3	91330 Shelf M1
91221 Transmit Unit	M1	✓	×
	M2	✓	✓
	M3	Note 2	✓
91222 Receive Unit	M1	✓	×
	M2	✓	Note 3
	M3	✓	✓
	M4	Note 2	✓
91230 Alarm Unit (see paragraphs 4.03 and 4.04)	M1	✓	Note 4
	M2	✓	✓
	M3	Notes 2, 5	✓
91235-01 Power Supply Unit	M1	✓	✓
	M2	✓	✓
91235-02 Power Supply Unit	M3	Notes 2, 6	✓

NOTES:
1. ✓ = usable; × = not usable.
2. Usable if 91220 shelf is modified per MK5.
3. 91222-M2 Issue 4 receive unit is usable in a 91330 shelf.
4. 91230-M1 alarm unit is usable in a 91330 shelf if the unit is modified per MK1 to enable bit 2 restoral.
5. 91230-M3 alarm unit is usable in a 91220 shelf if the channel bank at the far end is arranged for bit 2 restoral.
6. 91235-02 M3 power supply unit is usable in a 91220 shelf if the shelf does not contain a 91221-M1 transmit unit or a 91222-M1 or -M2 (Issues 1-3) receive unit.

3. END-TO-END COMPATIBILITY

3.01 In any PCM carrier system, the channel bank at each end must use the same system alarm restoral method. Channel banks should also use the same channel sampling sequence so that channels will appear at corresponding unit mounting positions in the shelf at each end of the system.

3.02 System Alarm Restoral. The two most common methods of automatic restoral from a system alarm condition are designated "bit 2" and "channel 12." Bit 2, the current network standard, is the only method available with newer equipment. The restoral method is a function of the alarm unit. In a system with a 91230-M3 unit at one or both ends, the bit 2 method must be used. Alarm unit capabilities are as follows:

(a) 91230-M1 (last shipped in February 1973): channel 12 only

(b) 91230-M1 with MK1: channel 12 or bit 2 (strap option)

(c) 91230-M2: channel 12 or bit 2 (strap option)

(d) 91230-M3 (first shipped in November 1975): bit 2 only

3.03 Channel Sampling Sequence. The sequence in which channels are sampled is a function of the terminal equipment shelf wiring. Three sequences (D1D, D2, and D3) are available as follows:

(a) 91220-M1 or -M2 shelf: D2 sequence only

(b) 91220-M3 shelf: D1D, D2, or D3. Sequence is selected by one of two optional pc board subassemblies, which provide D1D/D2 and D2/D3 sequences, respectively.

(c) 91330-M1 shelf: D1D, D2, or D3. Shelf is shipped arranged for D3 sequence; two optional channel pulse adapters provide D1D and D2 sequence, respectively.

4. SHELF AND UNIT COMPATIBILITY

4.01 Power Supply. In a 9002A channel bank, the 91235-01 M1 or M2 power supply unit produces two dc voltages (+3.6V and −3.6V) that are distributed only to J13 and J14 in the 91220 shelf for use in the units listed below. In the 9002B channel bank, these voltages are not produced by the 91235-02 M3 unit nor distributed by the 91330 shelf. Therefore, in a 91330 shelf (9002B) or in a 91220 shelf (9002A) equipped with a 91235-02 M3 unit, the following models of the transmit unit and receive unit cannot be used.

(a) 91221-M1 transmit unit (last shipped in June 1972)

(b) 91222-M1 receive unit (last shipped in May 1972)

(c) 91222-M2 receive unit, Issues 1 thru 3 (last shipped in March 1973)

4.02 Looped Receive Clock. Looped receive clock is used to synchronize inputs/outputs as required, for example, by digital switching machines. On channel banks synchronized by the looped receive clock option, the 91221 transmit unit must be M2 (modified per MK5 or MK6) or M3.

4.03 External Alarm Equipment. The system alarm relay in the 91230-M3 alarm unit has one set of form C contacts for controlling alarm equipment in an electronic exchange and another open/ground contact for controlling an external alarm counter. These circuits are not provided on the 91230-M1 and -M2 units. (All 91230 models include the standard audible and visual alarm contacts.)

4.04 The 91230-M3 alarm unit can be used in a 91220 shelf if the shelf is modified per optional MK6 or if screw-straps W, X, Y, and Z on the unit are open. MK6 removes wiring to make the alarm contacts available for external alarm equipment mentioned above but prevents use of the channel 12 method of simultaneous restoral; only the bit 2 method can be used.

CAUTION: Don't use the 91230-M1 or -M2 alarm unit (9002A) in a 9002B shelf if external equipment mentioned above is connected to the shelf unless the 91230-M1 or -M2 unit includes optional MK6. An unmodified unit will be damaged by the voltage from external equipment.

GTE Practices
Engineering—Plant Series
GTE LENKURT

Addendum 342—911—111
Issue 2, November 1981

9004A PCM Channel Bank FUNCTIONAL OPERATION, ENGINEERING, AND ORDERING

1. GENERAL

1.01 This Addendum to Section 342-911-111, Issue 2, is reissued to furnish information about the following:

Clock latching circuit on the 91400 shelf
91400-M2 Terminal Equipment Shelf
91420-02 Alarm Control Unit
91426-M2 Syndes Unit
91433-M2 Receive Unit
91448-02 Office Interface Unit
Additional channel units, including digital data and program types

1.02 Changes described in Issue 1 of this Addendum are also included in this issue. Changes appearing for the first time are indicated by marginal arrows. In ink or red pencil, make the changes described in Part 2 or write "See Addendum" in the margin adjacent to the change. Remove Issue 1 of Addendum 342-911-111 from the binder or microfiche file and replace it with this issue.

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2. CHANGES

● 2.01 Page 2, Technical Summary, under headings VF Channels and Bandwidth, change "3300 Hz" to "3200 Hz."

▶● 2.02 Page 5, figure 1-2, delete the last line and add the following:

91407 4W Tandem	342-911-119
91408 FXO and 91409 FXS	342-911-115
91411 4W Loop Simplex Originating	342-911-118
91412 and 91413 Program Channel Units	342-911-126
91434 Four-Wire SF	342-911-120
91460, 91461, 91462 OCUDP and 91464 DS0DP Data Channel Units	342-911-132
91470 DPO/ICT and 91471 DPT/OGT Channel Units ◀	342-911-121

● 2.03 Page 6, paragraph 2.06, add the following after the first sentence: "("Digroup" stands for digital group.)."

▶● 2.04 Page 13, after paragraph 3.09, add the following new paragraphs 3.09a through 3.09h.

Clock Latching Circuit

3.09a The mode 3 receive unit recovers a 1.544-MHz clock from the DS1 signal of each digroup; the two clocks are designated Rcv Clk A and Rcv Clk B. Prior to Issue 5 of the 91400 shelf, in a channel bank operating with the looped receive clock option, Rcv Clk A is the primary transmit timing source for both digroups.

3.09b Clock Switching. If digroup A loses frame sync for longer than 60 ms, Rcv Clk B replaces Rcv Clk A as the transmit timing source during the reframing process. Then, Rcv Clk A is switched back in. Although the frame sync loss is in digroup A, the resultant clock switching also disturbs the DS1 transmit signal in digroup B.

3.09c An occasional reframing cycle is not a problem. However, frequent reframing in digroup A, typically caused by a marginal repeatered line, can degrade service in digroup B. The effects can be false seizures or disconnects, wrong numbers, ANI failures, false ringing, impulse noise, etc.

3.09d Clock Latching. Beginning with Issue 5, the 91400 shelf has a clock latching circuit that prevents repeated switching of the transmit clock source. Figure 3-2a is a simplified diagram of the clock control circuits, with heavy lines indicating the changes incorporated in the Issue 5 shelf. Paragraphs below explain circuit operation.

3.09e An AC1 lead from each digroup indicates frame sync status. Prior to Issue 5 of the 91400 shelf, if AC1 is logic 1 (out of frame) longer than 60 ms, a microcomputer in the 91420 Alarm Control Unit forces the associated AC7 lead to logic 1. (AC7 is also logic 1 during looped line (LL) or looped terminal (LT) status.) According to the logic states on AC7-A and AC7-B, the clock selector switches in Rcv Clk A, Rcv Clk B, or a crystal-controlled oscillator as the transmit timing source.

3.09f As shown in figure 3-2a, the clock latching circuit in the Issue 5 shelf is inserted in the AC7 paths and the AC1 leads have an additional path around the microcomputer. Logical operations are described below.

(a) Normally, all inputs to gates A and B are logic 0. At random, the outputs of the latch (gates C and D) at AC7-A and AC7-B are either 0 and 1 or 1 and 0. Consequently, the looped receive clock transmit timing source may be Rcv Clk A or Rcv Clk B.

(b) If Rcv Clk A is the transmit timing source and digroup A loses frame sync, AC1-A goes to logic 1, the latch changes state, and the clock selector switches to Rcv Clk B. Thereafter, the gate A inputs do not affect the latch. Rcv Clk B will stay on line despite repeated digroup A reframing cycles.

(c) The process when Rcv Clk B is the initial transmit timing source is similar to the one described in (b). That is, if digroup B loses frame sync, Rcv Clk A will be latched in as the transmit timing source.

(d) If both digroups lose frame sync, both AC7-A and AC7-B at the clock selector are logic 1 and the crystal-controlled oscillator becomes the transmit timing source.

3.09g Modification Kit MK2-91400 adds the clock latching circuit to a 91400 shelf, Issue 4 or earlier. The modification uses the same subassemblies and wiring shown in figure 3-2a.

3.09h The status of the clock latching circuit can be checked with a dc voltmeter connected between test point A (positive) on subassembly 087-57214-01 and ground.

(a) A meter reading of about +4 volts indicates Rcv Clk B is selected. If the digroup B receive line is shorted momentarily, the reading should change to about 0 volts. Shorting the line again several times should not change the reading.

(b) A meter reading of about 0 volts indicates Rcv Clk A is selected. If the digroup A receive line is shorted momentarily, the reading should change to about +4 volts. Shorting the line again several times should not change the reading.

● 2.05 Page 16, add the new figure 3-2a on page 3 of this Addendum. ◀

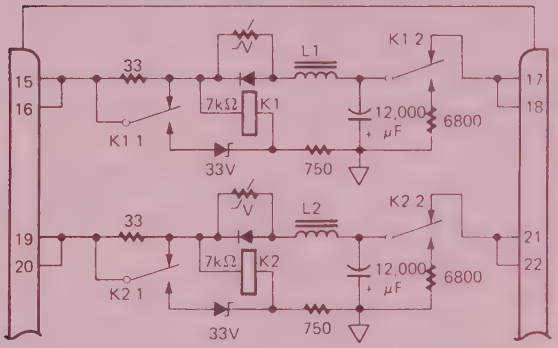
● 2.06 Page 17, figure 3-3, at the bottom of the cable symbol, change "(Note 2)" to "(Note 1)."

● 2.07 Page 18, figure 3-3, add the following single-line entry at the bottom of the table. The lead designations go in columns 37/, 38, 35/, and 36.

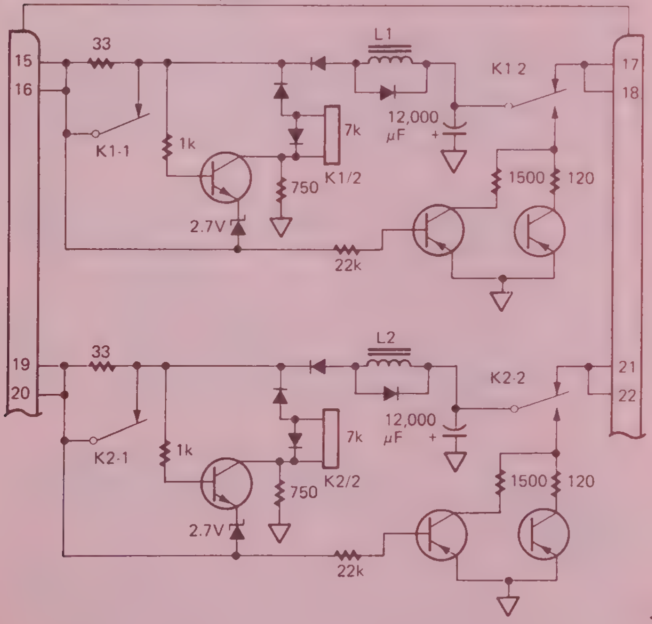
91411 4W Lp Splx Orig	T1, R1, T, R

▶● 2.08 Page 19, figure 3-4, replace the talk battery circuits of the 91424 Battery Filter Unit with the diagram below. (The 20-Hz and ground circuits of the 91424 do not change.)

91424 Battery Filter Unit Issue 3



▶ 91424 Battery Filter Unit, Issue 4



● 2.09 Page 20, figure 3-4, at the Bus 1 connection to the channel units (two places), change "23" to "25."

▶● 2.10 Page 22, replace figure 3-6 with the new figure 3-6 on page 4 of this Addendum. The new figure 3-6 shows wiring changes made by 91400-MK3 and the 91400-M2 shelf to enable channel bank operation with data channel units.

● 2.11 Page 40, after paragraph 3.107, add the following new paragraph 3.107a.

3.107a Model 2 of the 91433 receive unit has a connection from pin 23 of P2 to the center contact of the ON/OFF switch and a 10-kilohm resistor between +5V and the ON contact of the switch. When the 91433 is used in a 4691B FDM/PCM converter, pin 23 is grounded in the shelf to disable the tone generator.

● 2.12 Page 42, just ahead of paragraph 3.142, add the following Note:

NOTE: The circuit description that follows is based on the 91426 model 1 Syndes Unit shown in figure 3-20A. Operation of the model 2 syndes unit shown in figure 3-20C is similar when the unit is strapped for use in a 9004A channel bank.

● 2.13 Page 45, add sheet 3 of figure 3-20 on page 5 of this Addendum.

● 2.14 Page 46, add the following at the end of paragraph 3.174: "On a 91420-02 unit, a pulse through a 2-μF capacitor turns on a transistor momentarily to increment the SYS ALM peg count register."

● 2.15 Page 48, replace figure 3-21 with the new figure 3-21 on page 6 of this Addendum. ◀

● 2.16 Page 52, paragraph 3.224, first line, change "panel" to "91443-01 panel."

● 2.17 Page 52, add the following new paragraph after paragraph 3.224:

3.224a The left side and right side of the 91443-02 panel have the same configuration as the left side of the -01 panel; each side has two identical sets of jacks. The option codes of the -01 panel are not applicable to the -02 panel.

● 2.18 Page 53, figure 3-24, left side of center section, connect the tip of the LEVEL jack to the switching contact above it.

● 2.19 Page 54, figure 3-25, in the caption of Figure A, change "(1 of 2)" to "(1 of 2 on 91443-01, 1 of 4 on 91443-02)."

● 2.20 Page 54, figure 3-25, in the captions of figures B, C, and D, add "(91443-01 only)."

● 2.21 Page 56, replace paragraph 4.04 with the following:

4.04 The ventilation baffle can usually be omitted under any of the circumstances listed below. (If a ventilation baffle is not used, the 91400 shelf must be equipped with a top plate, Code AB.) ◀

● 2.22 Page 57, figure 4-1, add the following two-line entry about the 91411 channel unit at the bottom of the table.

Channel Unit	Idle	Busy
91411 4W LSO	48	36
Loop current		47

▶● 2.23 Page 59, just preceding paragraph 4.23, add the following note.

NOTE: If DS1 cables are limited to the lengths listed in figure 4-4 for DS1C cables, a channel bank operated initially in mode 3 can be converted later to mode 1 or mode 2 without relocating any equipment.

● 2.24 Page 60, add the following new paragraph 4.28.

Digital Switch

4.28 In digital switching and dataport (DDS services) applications of a mode 2 or mode 3 channel bank, the looped receive clock option must be used. Because the clock recovered from one digroup is used as the transmit timing source for both digroups (see paragraph 3.09a), the digroups of a mode 2 or mode 3 channel bank must not terminate at separate nonsynchronous digital switches. Further, to prevent future administrative and dataport problems in channel assignment, if only digroup A is used initially, digroup B shall be reserved for future allocation to the same digital switch. These restrictions will disappear in the future when the network plan that calls for all digital switches to be externally synchronized is implemented.

● 2.25 Page 61, replace figure 5-1 with the new figure 5-1 on page 7 of this Addendum.

● 2.26 Pages 61 and 62, replace figure 5-2 with the new figure 5-2 on pages 8 and 9 of this Addendum. ◀

● 2.27 Page 64, figure 5-4, in the right-hand column, add the following information about the 91443 Test Patch Panel.

-01 Two sets of channel unit access jacks, plus option code if applicable.

-02 Four sets of channel unit access jacks; option codes are not applicable.

▶● 2.28 Page 64, figure 5-4, in the second column, change "91444 Test Shelf" to "9140A Digital Test Set".

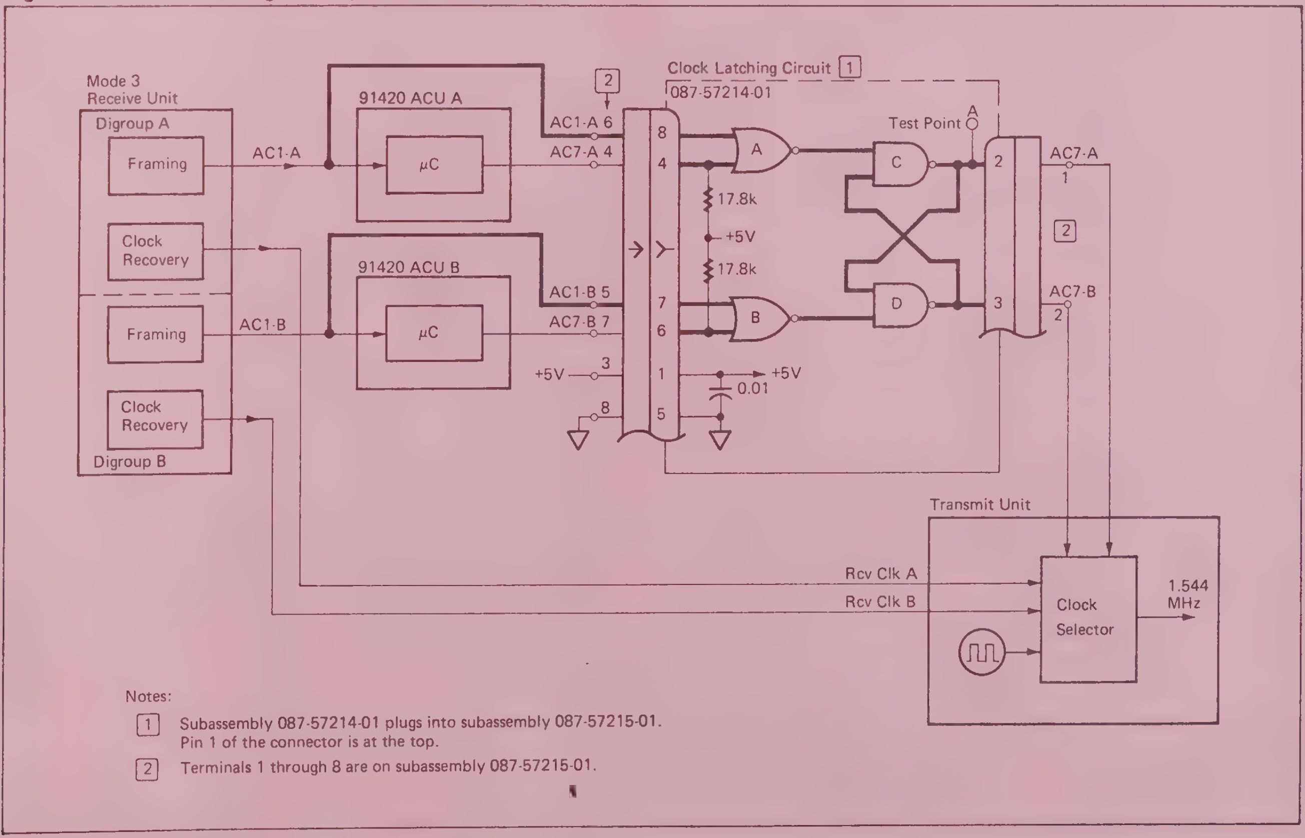
● 2.29 Page 64, figure 5-4, add the following new items.

796B Test Cord (035-56501-01). Two two-conductor cables 3 metres (10 feet) long with miniature tip-ring-sleeve telephone plugs on one end; the other ends terminate at the same printed circuit plug connector; used to access T-R and T1-R1 leads toward the carrier at a channel unit TEST receptacle connector. Recm Qty, Min per Site = 1.

796C Test Cord (035-56501-02). Two-conductor cable 3 metres (10 feet) long with a 310-type tip-ring-sleeve telephone plug on one end; the other end terminates at a printed circuit plug connector; used to access E&M leads toward the carrier at a channel unit TEST receptacle connector. Recm Qty, Min per Site = 1.

022-56637-01 Open Plug. Fiberglas board 44 × 27 × 1.6 mm (1.75 × 1.08 × 0.062 inches) with a 16-mm (5/8-inch) diameter finger hole; inserted in channel unit TEST receptacle connector to disconnect T-R, T1-R1, and E&M leads toward the office. Recm Qty, Min per Site = 24. ◀

▶ Figure 3-2a. Clock Latching Circuit, 91400 Shelf Issue 5



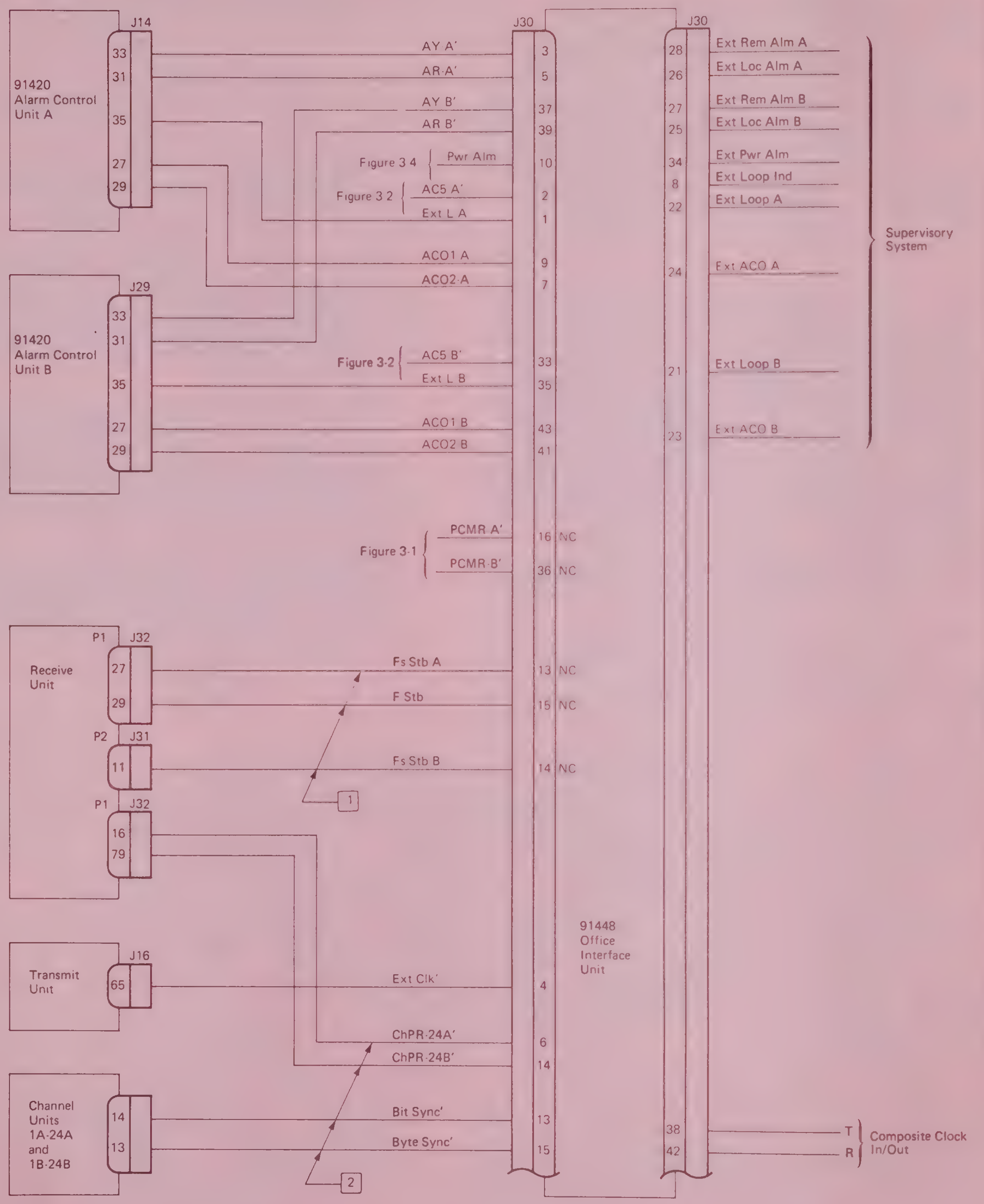
Notes:

1 Subassembly 087-57214-01 plugs into subassembly 087-57215-01. Pin 1 of the connector is at the top.

2 Terminals 1 through 8 are on subassembly 087-57215-01.

◀

Figure 3-6. Connections to 91448 Office Interface Unit


91420
Alarm Control
Unit A
J14
33
31
35
27
29
91420
Alarm Control
Unit B
J29
33
31
35
27
29
Receive
Unit
P1
J32
27
29
P2
J31
11
P1
J32
16
79
Transmit
Unit
J16
65
Channel
Units
1A-24A
and
1B-24B
14
13
AY A'
AR A'
AY B'
AR B'
Figure 3-4
Pwr Alm
Figure 3-2
AC5 A'
Ext L A
ACO1 A
ACO2 A
Figure 3-2
AC5 B'
Ext L B
ACO1 B
ACO2 B
Figure 3-1
PCMR A'
PCMR B'
Fs Stb A
F Stb
Fs Stb B
1
Ext Clk'
ChPR-24A'
ChPR-24B'
Bit Sync'
Byte Sync'
2
J30
3
5
37
39
10
2
1
9
7
33
35
43
41
16 NC
36 NC
13 NC
15 NC
14 NC
4
6
14
13
15
91448
Office
Interface
Unit
J30
28
26
27
25
34
8
22
24
21
23
38
42
Ext Rem Alm A
Ext Loc Alm A
Ext Rem Alm B
Ext Loc Alm B
Ext Pwr Alm
Ext Loop Ind
Ext Loop A
Ext ACO A
Ext Loop B
Ext ACO B
Supervisory
System
T
R
Composite Clock
In/Out

Notes:

1 91400-M1 Shelf. Wiring referenced to this note is on the model 1 shelf but the circuits are inactive. If the shelf is modified per MK3, the traces on the printed circuit backplane are cut and the wiring referenced to Note 2 is installed.

2 91400-M2 Shelf. Wiring referenced to this note is on the model 2 shelf or on a model 1 shelf modified per MK3.

Figure 3-20. 91426 Syndes Unit, Circuit Diagram (Sheet 3 of 3)

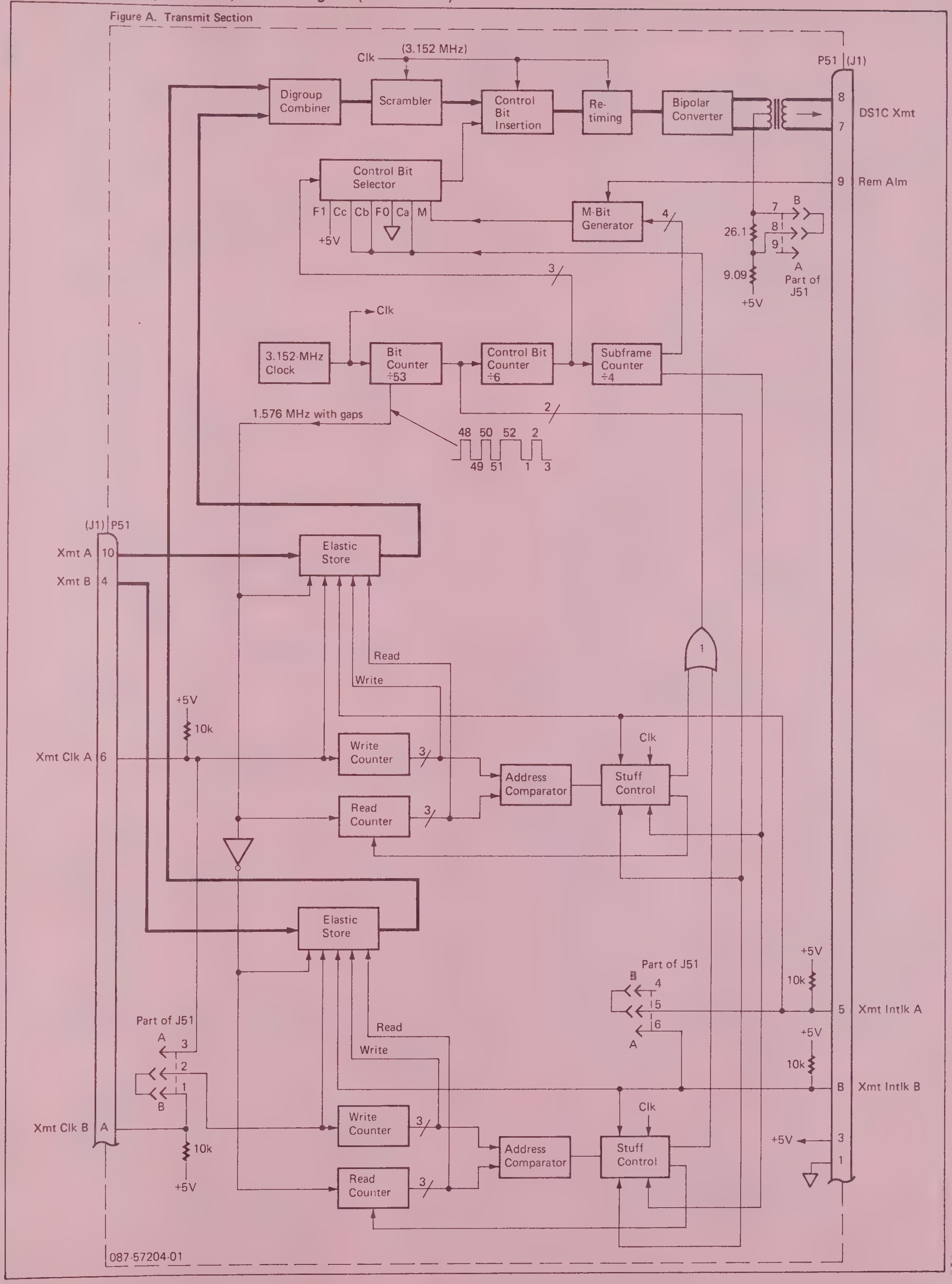
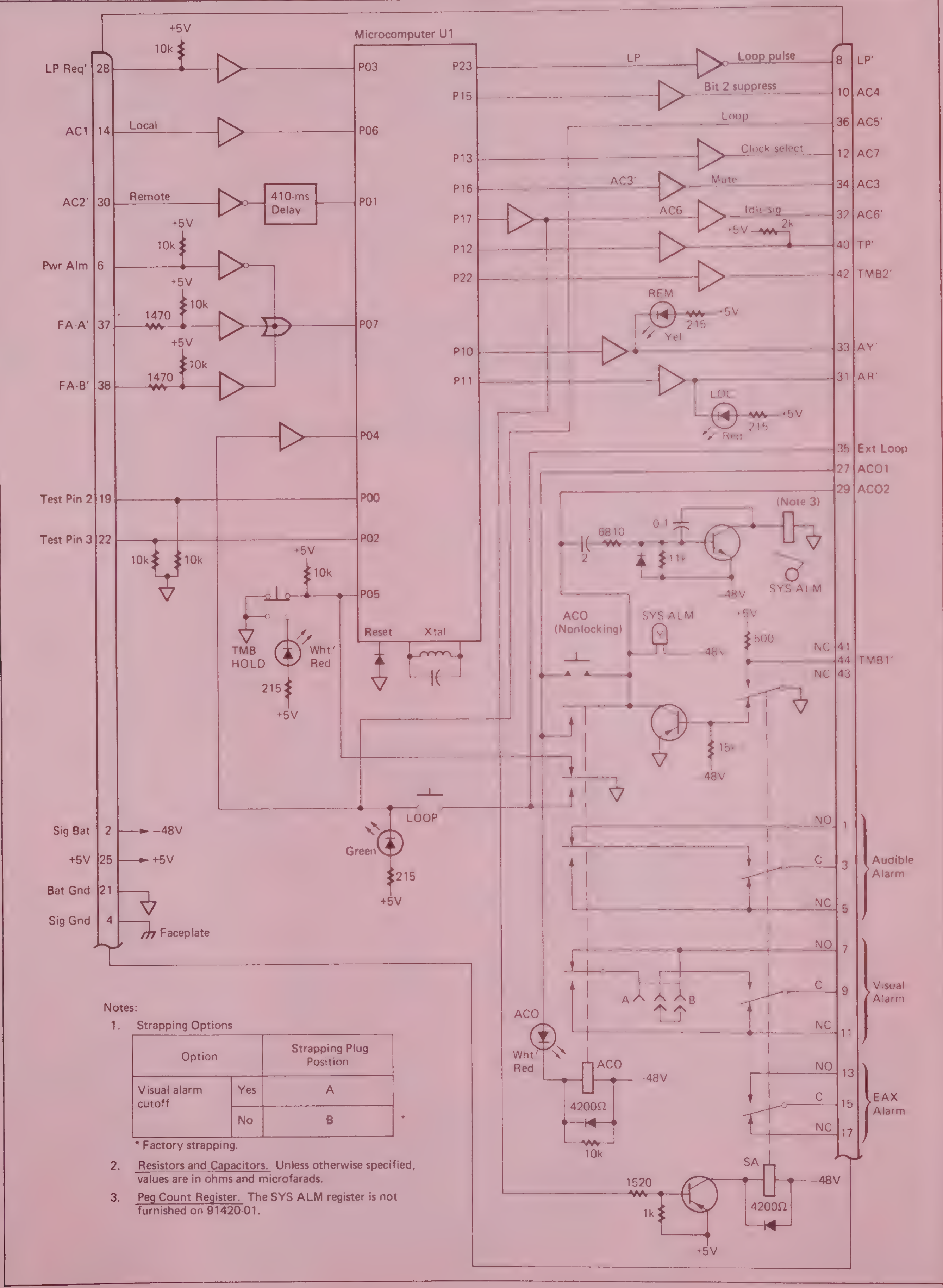


Figure A. Transmit Section

Clk
(3.152 MHz)
Digroup Combiner
Scrambler
Control Bit Insertion
Re-timing
Bipolar Converter
P51 (J1)
8
7
DS1C Xmt
9
Rem Alm
Control Bit Selector
F1 Cc Cb F0 Ca M
+5V
M-Bit Generator
4
7
B
8
9
26.1
9.09
A
Part of J51
+5V
3
Clk
3.152-MHz Clock
Bit Counter ÷53
Control Bit Counter ÷6
Subframe Counter ÷4
2
1.576 MHz with gaps
48 50 52 2
49 51 1 3
(J1) P51
Xmt A
10
Xmt B
4
Elastic Store
Read
Write
1
+5V
10k
Xmt Clk A
6
Write Counter
3
Clk
Address Comparator
Stuff Control
Read Counter
3
Elastic Store
+5V
Part of J51
B
4
5
10k
6
A
Xmt Intlk A
+5V
10k
Xmt Intlk B
Read
Write
Part of J51
A
3
2
1
B
Clk
Xmt Clk B
A
Write Counter
3
Address Comparator
Stuff Control
+5V
3
1
10k
+5V
Read Counter
3
087-57204-01

▶ Figure 3-21. 91420 Alarm Control Unit, Circuit Diagram


Microcomputer U1
LP Req' 28
AC1 14
Local
AC2' 30
Remote
410-ms Delay
Pwr Alm 6
FA-A' 37
FA-B' 38
1470
10k
+5V
Test Pin 2 19
Test Pin 3 22
TMB HOLD
Wht/Red
215
Reset
Xtal
P03
P06
P01
P07
P04
P00
P02
P05
P23
P15
P13
P16
P17
P12
P22
P10
P11
LP
Loop pulse
Bit 2 suppress
Loop
Clock select
AC3'
Mute
AC6
Idle sig
2k
REM
Yel
LOC
Red
8 LP'
10 AC4
36 AC5'
12 AC7
34 AC3
32 AC6'
40 TP'
42 TMB2'
33 AY'
31 AR'
35 Ext Loop
27 ACO1
29 ACO2
(Note 3)
0.1
6810
2
11k
-48V
SYS ALM
ACO (Nonlocking)
SYS ALM
Y
-48V
+5V
500
NC 41
44 TMB1'
NC 43
15k
48V
LOOP
Green
Sig Bat 2
-48V
+5V 25
+5V
Bat Gnd 21
Sig Gnd 4
Faceplate
NO 1
C 3
NC 5
Audible Alarm
NO 7
C 9
NC 11
Visual Alarm
A
B
NO 13
C 15
NC 17
EAX Alarm
ACO
Wht/Red
ACO
4200Ω
10k
-48V
SA
1520
1k
4200Ω
-48V
+5V

Notes:

1. Strapping Options

Option		Strapping Plug Position
Visual alarm cutoff	Yes	A
	No	B

* Factory strapping.

2. Resistors and Capacitors. Unless otherwise specified, values are in ohms and microfarads.
3. Peg Count Register. The SYS ALM register is not furnished on 91420-01.

Figure 5-1. List of Common Equipment

Type No.	Name	Qty for Mode			Description
		1	2	3	
91400-01 (model 2)	Terminal Equipment Shelf	1	1	1	Supports and interconnects eight common equipment units and 48 channel units. NOTE: Because of heat dissipation requirements, if a ventilation baffle (Code AA) will not be installed directly above the shelf on the rack, the shelf must be equipped with a top plate (Code AB). Code AA Ventilation baffle 024-56830-01 and mounting hardware; one rack mounting space. AB Top plate 020-56735-01 and mounting hardware. BA Channel assignment label 123-91400-01 and bracket 020-56730-01; for a front-mounted shelf; bracket attaches to shelf side plate. BB Channel assignment label 123-91400-01, bracket 020-56937-01, and mounting hardware; for a rear-mounted shelf on an unequal-flange duct type rack; bracket attaches to front of rack. CA DS1 cable equalizer 087-56705-01. CB DS1 cable equalizer 087-56705-02. CD DS1C cable equalizer 087-56705-03. CE DS1C cable equalizer 087-56705-04.
91420-xx	Alarm Control Unit	1	2	2 (*)	-01 Monitors channel bank status and provides visual alarm indications and system alarm relay contacts for office alarms. -02 Same as -01 and equipped with a resettable three-digit system alarm peg count register.
91421-01	Mode 1 Transmit Unit	1			Combines the eight-bit pcm words from 48 channels plus framing information into a single DS1C line signal; the format is not M1C compatible.
91422-01	Mode 2 Transmit Unit		1		For digroups A and B, combines the eight-bit pcm words from 24 channels plus framing information into two 1.576-Mb/s unipolar signals.
91423-01	Mode 3 Transmit Unit			1	For digroups A and B, combines the eight-bit pcm words from 24 channels plus framing information into two 1.544-Mb/s DS1 line signals.
91424-01	Battery Filter Unit	1	1	1	Optional; supplies talking battery to DPO and FXS channel units and 20-Hz ringing voltage to FXS channel units.
91425-01	Power Supply Unit	1	1	1	From a —48 volt dc input, supplies regulated dc voltages to units of the 91400-01 shelf. Voltages and maximum loads are: +5V at 3.6A, —5V at 0.25A, +12V at 0.8A, and —12V at 0.4A.
91426-01 (model 2)	Syndes Unit		1		Synchronizes and combines transmit signals of digroups A and B plus control bits into an M1C-compatible DS1C line signal; performs a reciprocal function in the receive direction.
91431-01	Model 1 Receive Unit	1			Demultiplexes the incoming DS1C line signal to recover the digital vf and signaling information for 48 channels.
91432-01	Mode 2 Receive Unit		1		Demultiplexes the unipolar pcm bit streams from the 91426 Syndes Unit to recover the digital vf and signaling information for 48 channels.
91433-01 (model 2)	Mode 3 Receive Unit			1	Demultiplexes two incoming DS1 line signals to recover the digital vf and signaling information for 48 channels.
91448-xx	Office Interface Unit	1	1	1	-01 Extends alarm and control leads to a supervisory and control system such as GTE Lenkurt System 51. -02 Same as -01, plus supplies 64-kHz bit sync and 8-kHz byte sync signals to data channel units. These signals are derived from a 64-kHz composite clock, which may be an input or output as a strapping option. With the input option, the composite clock synchronizes generation of a 1.544-MHz or 3.152-MHz clock supplied to the transmit units. With the output option, a composite clock is generated and synchronized with receive timing in either digroup.

*If only one digroup will be in service, an alarm control unit for the other digroup should not be installed.

Figure 5-2. List of Channel Units (Sheet 1 of 2)

Type	Channel Unit	Drop Impedance	Drop Levels		Features and Codes	Signaling and Supervisory Strapping Options
			Transmit	Receive		
E&M	91402-xx Two-Wire E&M (model 2)	-01: 900Ω + 2.15 μF -02: 600Ω + 2.15 μF	—4.5 to +1.8 dBm	0 to —6.3 dBm	C1 lead (Code A, 087-56916-01) NBOC (Note 1) A and B leads, 80 mA	Signaling interface: Sig Lead — Intfc Type — On-hook/Off-hook Receive — I, III Std — Open/ground I PLR — Ground/battery II — Open/closed Transmit — I, III Std — Ground/battery I PLR — Open/ground II — Open/battery E lead during system alarm: On-hook Off-hook On-hook 2 seconds, then off-hook NORM/BUSY switch in BUSY: Local busy Remote busy Local and remote busy Signaling battery source: Internal External via F lead Midpoint capacitor for A and B leads (91402-xx): Internal External
	91404-01 Four-Wire E&M (model 2)	600Ω	—17.5 to —11.2 dBm (Note 2)	+8.5 to +2.2 dBm (Note 2)	C1 lead (Code A, 087-56916-01)	
Loop	91403-01 Dial Pulse Originating (DPO)	900Ω + 2.15 μF	—4.5 to +1.8 dBm	0 to —6.3 dBm	CPFR NBOC (Note 1) 1800Ω loop	C lead busied by: Transmit off-hook Transmit or receive off-hook SxS selector: Open-seeking Battery-seeking Control/alarm leads: C OS or S B1-B2 ATB lead and: EC lead Peg-count lead, 100-ms ground pulse CPFR: With delay-dial or wink supervision With answer supervision No CPFR Battery at two-wire port: Normal battery in alarm Delayed (2 s) reverse battery in alarm Nonreversing battery
	91405-01 Dial Pulse Terminating (DPT)	900Ω + 2.15 μF	—4.5 to +1.8 dBm	0 to —6.3 dBm	Pulse corrector (Code A, 087-56911-01) C lead NBOC (Note 1) Seize 900Ω loop, pulse 200Ω loop	Off-hook wink is transmitted as a signaling integrity check when C lead is closed to ground externally after seizure. Reverse-to-normal transition on two-wire drop produces an extended guard delay of 40 or 200 ms; with Code A, the delay is 600 ms.
No sig	91401-01 Four-Wire (model 2)	600Ω	—17.5 to —11.2 dBm (Note 2)	+8.5 to +2.2 dBm (Note 2)		
FX	91407-01 Four-Wire Tandem	600Ω	—17.5 to —11.2 dBm (Note 2)	+8.5 to +2.2 dBm (Note 2)	Eight-wire interface; electronic signaling leads E1, E2, M1, and M2 (Note 4)	
	91408-01 Foreign Exchange Office (FXO) (model 2)	600 or 900Ω + 2.15 μF	—10.9 to +1.8 dBm	+2.0 to —10.7 dBm	NBOC (Note 1) Pulse corrector (Code A, 087-57028-01); not on model 1 Balance network (Note 3) Seize 1300Ω loop, pulse 800Ω loop	Signaling mode: Loop start Ground start Signaling format: No. 3 EAX interface D3/D4 Trunk-make-busy: Idle; with or without C lead Idle 2 seconds, then busy; with or without C lead
	91409-01 Foreign Exchange Subscriber (FXS)	600 or 900Ω + 2.15 μF	—10.9 to +1.8 dBm	+2.0 to —10.7 dBm	NBOC (Note 1) Balance network (Note 3) 1800Ω loop	Signaling mode: Loop start Ground start Signaling format: No. 3 EAX interface D3/D4 Trunk-make-busy: Idle; ringing inhibited Idle 2 seconds, then busy

Figure 5-2. List of Channel Units (Sheet 2 of 2)

Type	Channel Unit	Drop Impedance	Drop Levels		Features and Codes	Signaling and Supervisory Strapping Options
			Transmit	Receive		
TSPS	91411-01 Four-Wire Loop Simplex Originating	600Ω	—4.5 to +1.8 dBm	—1.5 to —7.8 dBm	For TSPS service	TMB: Normal battery Reverse battery if loop is open; if loop is closed, normal battery to stop charges, then reverse battery 200 ms after loop is opened
Program	91412-xx 5/8 kHz Program Transmit	150 or 600Ω	+3 to +18 dBm		Cable equalizer -01: with equalizer -02: without equalizer Switch-selectable bandwidth: 5 or 8 kHz Switch-selectable pre-emphasis	
	91413-01 5/8 kHz Program Receive	150 or 600Ω		+3 to +18 dBm	Switch-selectable bandwidth: 5 or 8 kHz Switch-selectable de-emphasis	
Digital data	91460-01 OCUDP Data	135Ω	—31 to +6 dBm	+6 dBm	Data rate 2.4 kb/s Error correction	
	91461-01 OCUDP Data	135Ω	—31 to +6 dBm	+6 dBm	Data rate 4.8 kb/s Error correction	
	91462-01 OCUDP Data	135Ω	—31 to +6 dBm	0 dBm	Data rate 9.6 kb/s Error correction	
	91464-01 DS0D' Data	100Ω	3.4 v b-p	1 v b-p minimum	Optional error correction	
Special purpose	91434-01 Four-Wire SF	600Ω	+5.5 to +7 dBm	—14.5 to —16 dBm	Pulse correction Microprocessor signaling control	Sf signaling: Normal Disabled for CCIS Fdm TMB: On-hook On-hook, then off-hook 60 or 90 ms after pcm rcv goes on-hook Pcm TMB: On-hook On-hook, then off-hook 60 or 90 ms after fdm rcv goes on-hook NORM/BUSY switch in BUSY: Local busy Remote busy Local and remote busy
	91470-xx DPO/ICT	900Ω + 2.15 μF	—10.9 to +1.8 dBm	+2 to —10.7 dBm	For service with GTD-5 or GTD-3 EAX Loop length -01: 200 to 2000Ω -02: 1800 to 3000Ω NBOC (Note 1) Balance network (Note 3)	TMB: Normal battery Delayed (2 s) reverse battery
	91471-01 DPT/OGT	900Ω + 2.15 μF	—10.9 to +1.8 dBm	+2 to —10.7 dBm	For service with GTD-5 or GTD-3 EAX Pulse corrector (Code A, 087-56911-01) NBOC (Note 1) Balance network (Note 3)	Pulsing: Loop Battery/ground

Notes:

1. NBO Capacitance. NBOC is strappable from 0 to 0.126 μF in 0.002-μF steps.
2. Four-Wire VF Drop Levels. Transmit and receive levels shown for the 91401, 91404, and 91407 channel units are for nontandem applications with the TANDEM attenuators strapped for 0 dB. Level ranges for all settings of the TANDEM attenuators are listed in figure 3-8.
3. Balance Networks. Optional hybrid balance networks for the 91408, 91409, 91470, and 91471 channel units are listed below:

Code	Part No.	Cable Loading and Gauge
AA	087-56976-01	H88 loading; 19 or 22 AWG (0.9 or 0.63 mm)
AB	087-56977-01	H88 loading; 24 or 26 AWG (0.5 or 0.4 mm)
AC	087-56975-01	D66 loading; 19 or 22 AWG (0.9 or 0.63 mm)
AD	087-56978-01	Nonloaded cable

4. Tandem Channel Unit. The 91407-01 cannot be used on a channel that terminates in a subscriber-type channel unit of the 9002A/B channel bank. The ringing signal to the subscriber, which is transmitted via the voice path, would be blocked by the 180-3400 Hz passband of the 91407-01.

GTE Practices
Engineering—Plant Series
GTE LENKURT

Section 342—911—111
Issue 2, April, 1980

9004A PCM Channel Bank

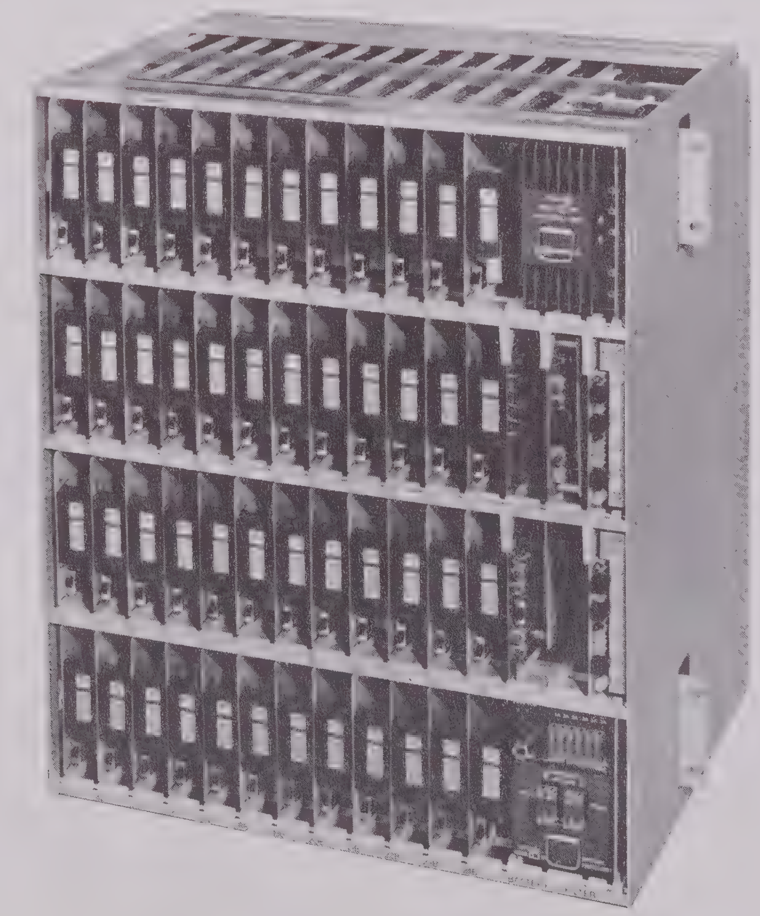
FUNCTIONAL OPERATION, ENGINEERING, AND ORDERING

APPLICATIONS

- Multiplexes up to 48 voice channels for high-quality, toll-grade transmission.
- Ideal for voice and data communications in direct, tandem, toll-connecting and intertoll applications.
- Basic signaling options include E&M, loop dial and foreign exchange.
- End-to-end compatible with WECo D3 or D4 channel banks including D4 modes 1, 2, and 3.
- Fully end-to-end compatible with GTE Lenkurt 9122A Asynchronous Digital Multiplexer and WECo M1C equipment.

FEATURES

- Small size (12 mounting spaces) increases channel density.
- Low power consumption reduces heat and central office power requirements.
- Channel bank is fully self-contained with primary power fuses and optional plug-in talk battery filter.
- No alignment adjustments required.
- Connectorized vf and signaling/supervisory leads through eight standard 50-pin connectors.
- Connectorized alarm leads speed installation.
- Simplified test equipment and testing procedures.
- Individual A/D and D/A conversion per channel improves crosstalk and noise performance.
- Supervisory state memory holds on-hook or off-hook condition during frame search.
- Line interface is compatible with DSX-1 and DSX-1C requirements.
- Transmit timing can be strapped for internal clock, looped receive clock or external clock operation.
- Channel unit normal-through jacks provide two-direction vf and signaling access.
- Integrated and thick-film circuitry and LSI devices throughout — ensures high reliability.



TECHNICAL SUMMARY

VF Channels (*)

Number	48	
Levels (see figures 3-8 and 5-2 for adjustment ranges)		
Two-wire	0 dBm transmit; −3 dBm receive	
Four-wire	−16 dBm transmit; +7 dBm receive	
Vf level stability (20 years, 95% of circuits)	±0.5 dB of reference loss	
Bandwidth (loss relative to 1-kHz loss)	2W to 2W	4W to 4W
200 Hz	0 to 5 dB	0 to 3 dB
300 to 3000 Hz	−0.5 to +1 dB	−0.3 to +0.3 dB
3300 Hz	1.5 dB max	1.5 dB max
3400 Hz	0 to 3 dB	0 to 3 dB
Impedance		
Two-wire	600 or 900 ohms plus 2.15 μF	
Four-wire	600 ohms	
Two-wire return loss		
ERL (weighted)	28 dB minimum	
SRL (weighted)	20 dB minimum	
Interchannel crosstalk	Less than 25 dBrnc0	
Idle noise (all channels terminated)	23 dBrnc0 maximum	
Impulse noise		
Digital loopback; drops not connected	Threshold level	Maximum counts in 30 minutes
	41 dBrnc0	10
	51 dBrnc0	1
	58 dBrnc0	0.1
End-to-end	58 dBrnc0, maximum 5 counts in 5 minutes	

*Refer to GTEP Sections listed in figure 1-2 for additional vf and signaling specifications of particular channel unit types.

Digroup Signal

Frame organization	24 eight-bit channel pcm words plus one framing bit (193 bits total)	
Channel pcm word (12-frame interval)		
Frames 1 through 5	Eight vf information bits	
Frame 6	Seven vf information bits and one "A" signaling bit	
Frames 7 through 11	Eight vf information bits	
Frame 12	Seven vf information bits and one "B" signaling bit	
Framing bit pattern (12-frame interval)		
Terminal framing bit	101010 in odd-numbered frames 1 through 11	
Signaling framing bit	001110 in even-numbered frames 2 through 12	
Signaling on vf channels		
Signaling channels	Two (A and B)	
Bit rate	1333 b/s (666 b/s on A and B)	
Coder-decoder (Codec)	Per-channel type; approximates μ-255 companding law	
Channel sampling sequence	D3 (1,2,3,....24)	
Timing	Modes 1 and 2	Mode 3
Clock frequency	1.576 MHz	1.544 MHz
Channel sampling rate	8000 Hz	8000 Hz
Bit time slot	634 ns	648 ns
Channel pcm word (8 bits)	5.07 μs	5.18 μs
Frame	125 μs (197 bits)	125 μs (193 bits)
Compatibility	End-to-end compatible with WECo D3 and D4 (modes 1, 2, and 3) channel banks	

See add

DS1 Interface (Mode 3)

Line rate	1.544 Mb/s ±200 b/s
Line code	Bipolar
Transmit pulse characteristics	
Base-to-peak height	6 volts ±10% into a 6-dB pad or cable equalizer
Unbalance in height of positive and negative pulses	±0.3 volt
Half-amplitude width	324 ±30 ns
Unbalance in width of positive and negative pulses	±15 ns

TECHNICAL SUMMARY (Continued)

Transmit pulse characteristics (Continued)	
Maximum rise or fall time	80 ns
Minimum density	Normally 1 in 8; not more than 15 consecutive zeros
Receive pulse amplitude, base-to-peak	1.5 to 3.3 volts
Pulse characteristics at DSX-1	
Amplitude, base-to-peak	3.0 volts ±10%
Width at 50% amplitude	324 ±30 nanoseconds
Line impedance	100 ohms nominal
Maximum cable length to DSX-1	
GTS-8507 cable	166 metres (544 feet)
GTS-8510 or ABAM cable	200 metres (655 feet)

DS1C Interface (Modes 1 and 2)

Frame organization	
Mode 1 (pseudo M1C)	Two interleaved synchronous digroup signals plus an eight-bit pattern of framing bits (394 bits total)
Mode 2 (M1C)	Two interleaved asynchronous digroup signals plus a 24-bit pattern of control bits (1,272 bits total)
Signal statistics	Average pulse density at least 1 in 8 over 130 consecutive time slots
Line rate	3.152 Mb/s ±30 ppm
Line code	Bipolar
Pulse amplitude, base-to-peak	3P 15T
Transmit unit output	3.95 volts ±10% into a 2-dB pad or cable equalizer
Receive unit input	1.7 to 3.3 volts P
Pulse characteristics at DSX-1C	
Amplitude, base-to-peak	3.0 volts ±10%
Width at 50% amplitude	160 ±20 nanoseconds
Power ratio, positive to negative pulses	Less than 0.5 dB
Line impedance	110 ohms ±5% balanced
Maximum cable length to DSX-1C	
GTS-8507 cable	105 metres (344 feet)
GTS-8510 or ABAM cable	122 metres (400 feet)

Input Power

Voltage	44 to 56 volts dc (48 volts nominal)
Current to a fully-equipped channel bank (*)	
With 48 E&M channel units	1.0 ampere
With 24 DPO and 24 DPT channel units	1.5 amperes plus loop currents

*Refer to figure 4-1 for detailed current requirements.

Environment

Ambient temperature range	0 to 50°C (32 to 122°F)
Maximum relative humidity	95% noncondensing at 40°C (104°F)
Maximum operating altitude	4500 metres (15,000 feet)

Physical Arrangement

Rack mounting	Standard 483-mm (19") rack; 356 mm (14") overall depth with 127 mm (5") forward projection from rack mounting surface
Mounting spaces, 44-mm (1-3/4-inch)	12-space shelf plus an optional 1-space ventilation baffle
Weight, fully equipped	36 kg (80 pounds) maximum

TECHNICAL SUMMARY (Continued)

Equipment

	Weight		Dimensions, high × wide × deep	
	kg	(Lb)	Millimetres	(Inches)
91400 Terminal Equipment Shelf	10	(22)	533 × 439 × 356	(21 × 17.3 × 14)
91420 Alarm Control Unit	0.18	(0.4)	*	
91421 Mode 1 Transmit Unit	0.23	(0.5)	*	
91422 Mode 2 Transmit Unit	0.23	(0.5)	*	
91423 Mode 3 Transmit Unit	0.23	(0.5)	*	
91424 Battery Filter Unit	1.6	(3.5)	121 × 83 × 292	(4.75 × 3.25 × 11.5)
91425 Power Supply Unit	1.5	(3.3)	121 × 88 × 292	(4.75 × 3.45 × 11.5)
91426 Syndes Unit	0.36	(0.8)	*	
91431 Mode 1 Receive Unit	0.23	(0.5)	*	
91432 Mode 2 Receive Unit	0.23	(0.5)	*	
91433 Mode 3 Receive Unit	0.23	(0.5)	*	
91442 VF Test Set	5.8	(12.8)	124 × 413 × 231	(4.88 × 16.25 × 9.1)
91445 Signaling Path Test Set	0.54	(1.2)	*	
91448 Office Interface Unit (future)	0.27	(0.6)	*	
Channel unit (typical)	0.41	(0.9)	*	

*Envelope dimensions for a one-slot unit are 121 × 27 × 292 mm (4.75 × 1.05 × 11.5 inches).

3000A Transport and Storage Shelf	1.9	(4.2)	3 or 4 rack mounting spaces
5215B Miniature Jackfield Assembly	2.3	(5)	1 rack mounting space
56620 Writing Shelf	2.5	(5.5)	1 rack mounting space
91232 Test and Alignment Set	6.4	(14)	2 rack mounting spaces
91443 Test Patch Panel	0.74	(1.6)	1 rack mounting space
91444 Test Shelf	5.4	(12)	3 rack mounting spaces
91455 Fuse and Alarm Panel	2.3	(5)	1 rack mounting space

GTE Lenkurt may change performance specifications where necessary to meet industry requirements.

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CD = Circuit Diagram

1. GENERAL

1.01 This Section is a general description of the 9004A PCM Channel Bank and associated equipment, and includes engineering considerations and ordering information. The 9004A is a pcm trunk carrier terminal with a digital input/output of two 24-channel DS1 signals or one 48-channel DS1C signal. It may be used for direct, tandem, toll-connecting, and intertoll applications.

1.02 Associated publications are listed in figures 1-1 and 1-2. Channel bank installation, testing, and troubleshooting procedures are in Section 342-911-112.

1.03 The equipment covered in this Section is the latest model as of the publication date. Later models are capable of greater application or are more effective in performance of their function than earlier models. A later model supersedes an earlier model of the same type number and may always be substituted for the earlier model.

1.04 This Section is reissued to add functional descriptions and circuit diagrams of the equipment. Other additions and changes are made throughout the Section. This issue also incorporates Issue 1 of Addendum 342-911-111, which added information about rack and office cabling, 91400 shelf option codes, and the 91004-22 standard rack assembly. Because of the extensive changes, marginal arrows are omitted.

1.05 Remove Issue 1 of this Section and Issue 1 of Addendum 342-911-111 from the binder or microfiche file and replace them with this issue.

CAUTION: The plug-in units listed below contain MOS devices, which can be damaged or destroyed by electrostatic voltages. Such voltages may be generated spontaneously by personnel in their everyday actions. Units should be stored in their antistatic shipping containers until they are installed in the channel bank. Special handling instructions are given in GTEP Section 300-910-300.

Channel units (all types)
Receive units (91431, 91432, 91433)
Alarm control unit (91420)

Figure 1-1. Associated Publications

Equipment	GTE Practices Section
5215B Miniature Jackfield Assembly	342-521-100
9002B PCM Channel Bank (includes 91232 test set)	342-911-107
9004A PCM Channel Bank, Installation and Maintenance	342-911-112
9104A PCM Repeatered Line Equipment, Inside Plant	342-910-105
9122A Asynchronous Digital Multiplexer	342-911-122
9148A Modified Duobinary Repeatered Line Equipment	342-910-104
91444 Test Shelf	342-911-125
Telephone Central Office Grounding of Transmission Equipment	795-805-073

Figure 1-2. Channel Unit Publications

Channel Unit	GTE Practices Section
91401 Four-Wire	342-911-116
91402 2W E&M and 91404 4W E&M	342-911-114
91403 DPO and 91405 DPT	342-911-117
91407 4W Tandem, 91408 FXO, and 91409 FXS	342-911-115

2. DESCRIPTION

2.01 The 9004A PCM Channel Bank (see front page) consists of a 91400 Terminal Equipment Shelf, up to eight common equipment units, and up to 48 channel units. Unit mounting positions are identified in figure 2-1. Shelf receptacle connectors are keyed or offset to prevent units from being inserted in the wrong positions.

2.02 Figure 2-2 is a photograph of the 91426 Syndes Unit, a common equipment unit used in mode 2 operation. ("Syndes" stands for synchronizer-desynchronizer and is pronounced sin'dēs.)

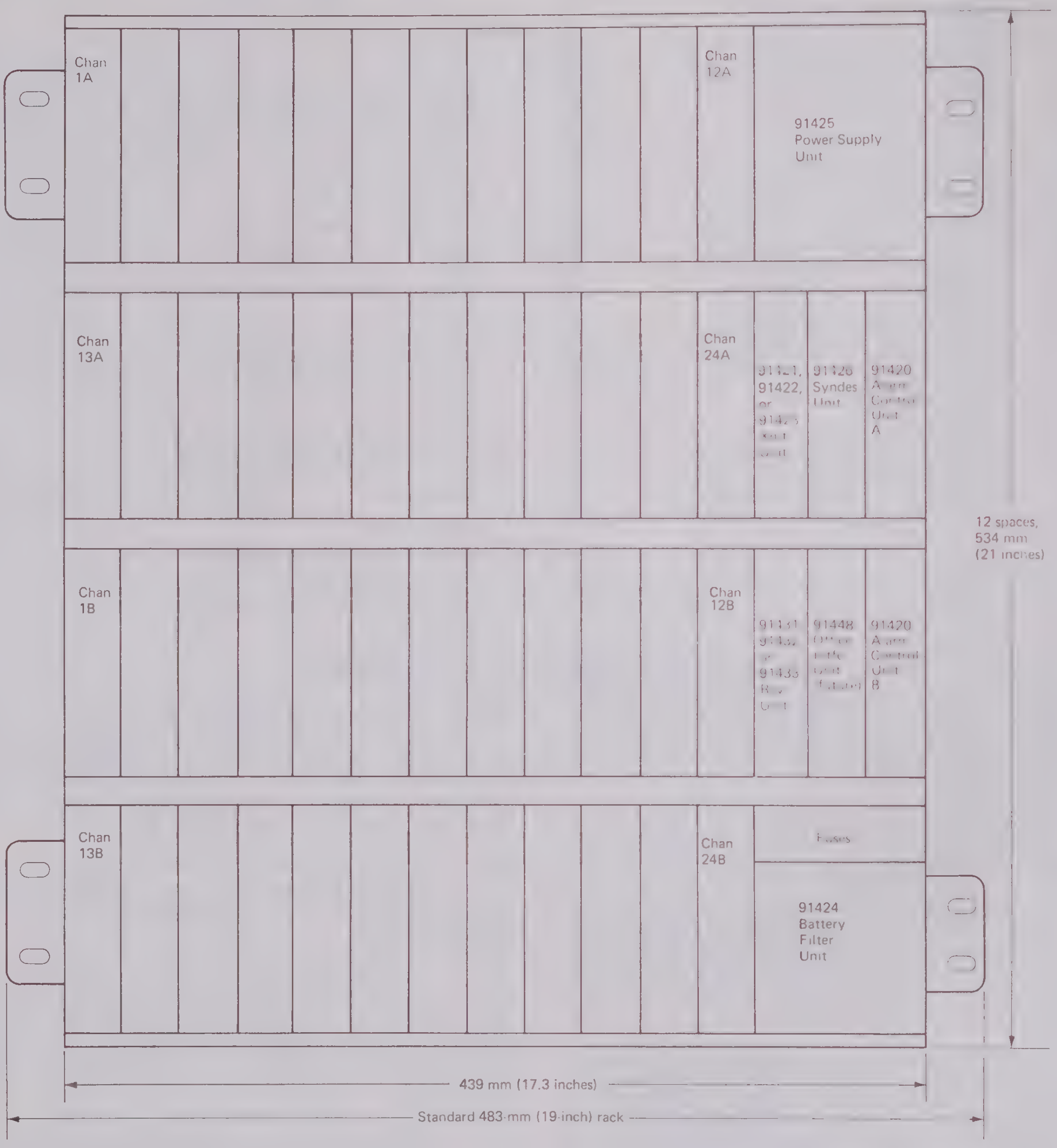
2.03 The shelf occupies 12 mounting spaces on a standard 483-mm (19-inch) rack. The channel bank is fully self-contained with its own primary dc power fuse, internal talking battery filter (optional), connectorized alarm interface, and eight 50-pin receptacle connectors for cabling the vf and signaling/supervisory leads of 48 channels to the office equipment.

2.04 The 9004A meets the applicable AT&T compatibility specifications for electrical performance, including alarm and restoral sequences. The companding characteristic approximates the μ-255 law, the frame and signaling format is 7-5/6 bits, and the channel sampling sequence is D3.

Operational Modes

2.05 The channel bank periodically samples the vf and signaling/supervisory inputs of 48 channels, converts the analog voltage values into binary digits, and combines these bits into a time-division multiplex signal. At the far end of the system, the channel bank converts the digital signal back to analog signals on the 48 channels.

Figure 2-1. Front View of Channel Bank

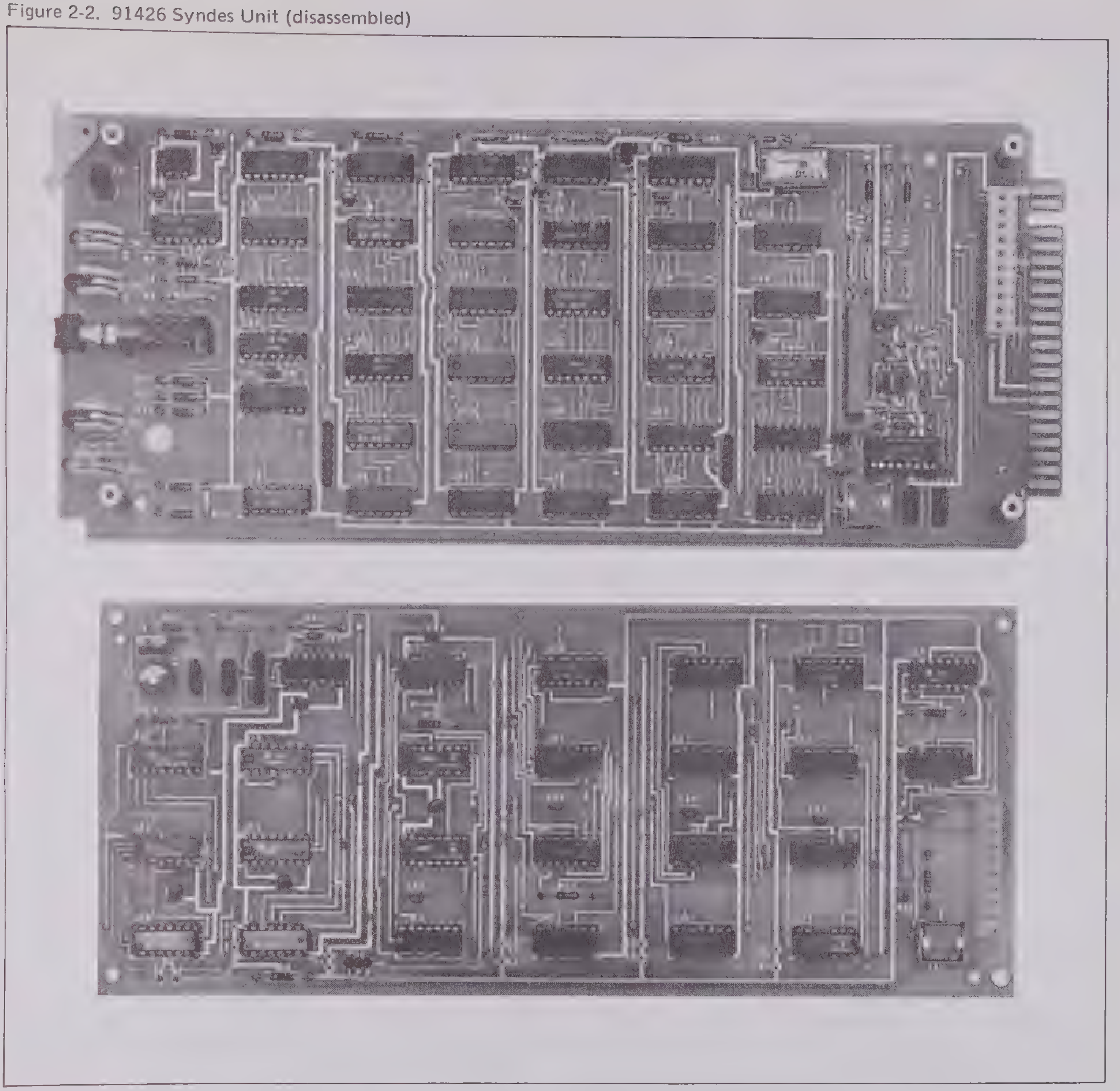

Chan 1A
Chan 12A
91425 Power Supply Unit
Chan 13A
Chan 24A
91421, 91422, or 91423 Xmit Unit
91426 Syndes Unit
91420 Alarm Control Unit A
Chan 1B
Chan 12B
91431 91432 or 91433 Rcv Unit
91448 Office Interface Unit (Future)
91420 Alarm Control Unit B
Chan 13B
Chan 24B
Fuses
91424 Battery Filter Unit
12 spaces, 534 mm (21 inches)
439 mm (17.3 inches)
Standard 483-mm (19-inch) rack

2.06 Basically, the vf channels of the 9004A are organized into two digroups, channels 1A through 24A in digroup A and channels 1B through 24B in digroup B. By means of appropriate plug-in common equipment units, four operating modes can be established. Applications of the four modes are illustrated in figure 2-3 and summarized below.

(a) Mode 1. The digital line interface is a single 48-channel DS1C signal (3.152 Mb/s) suitable for transmission over conventional T1C span lines or modified duobinary span lines (9148A or equivalent). The distant terminal must be a 9004A or WECo D4-type channel bank operating in mode 1. The two digroup signals are synchronized in frequency and interleaved into 394-bit frames, but the frame format is not compatible with an M1C multiplexer.

(b) Mode 2. Same as mode 1, except the frame format is M1C. The two digroups are synchronous in the outgoing transmit signal but not necessarily in the incoming receive signal. The distant terminal may be a 9004A or WECo D4-type channel bank operating in mode 2 or a 9122A or M1C multiplexer with WECo D3-type channel banks.

Figure 2-2. 91426 Syndes Unit (disassembled)



(c) Mode 3. The digital line interface is two 24-channel DS1 signals (1.544 Mb/s) suitable for transmission over two standard 9101C (T1) span lines. The DS1 signals are synchronous in the transmit direction but not necessarily in the receive direction. In this mode, the 9004A functions as two essentially independent 24-channel terminals.

(d) Mode 4 (future). Two colocated 9004A's generate a single 96-channel DS2 line signal (6.312 Mb/s).

Digital Signal Format

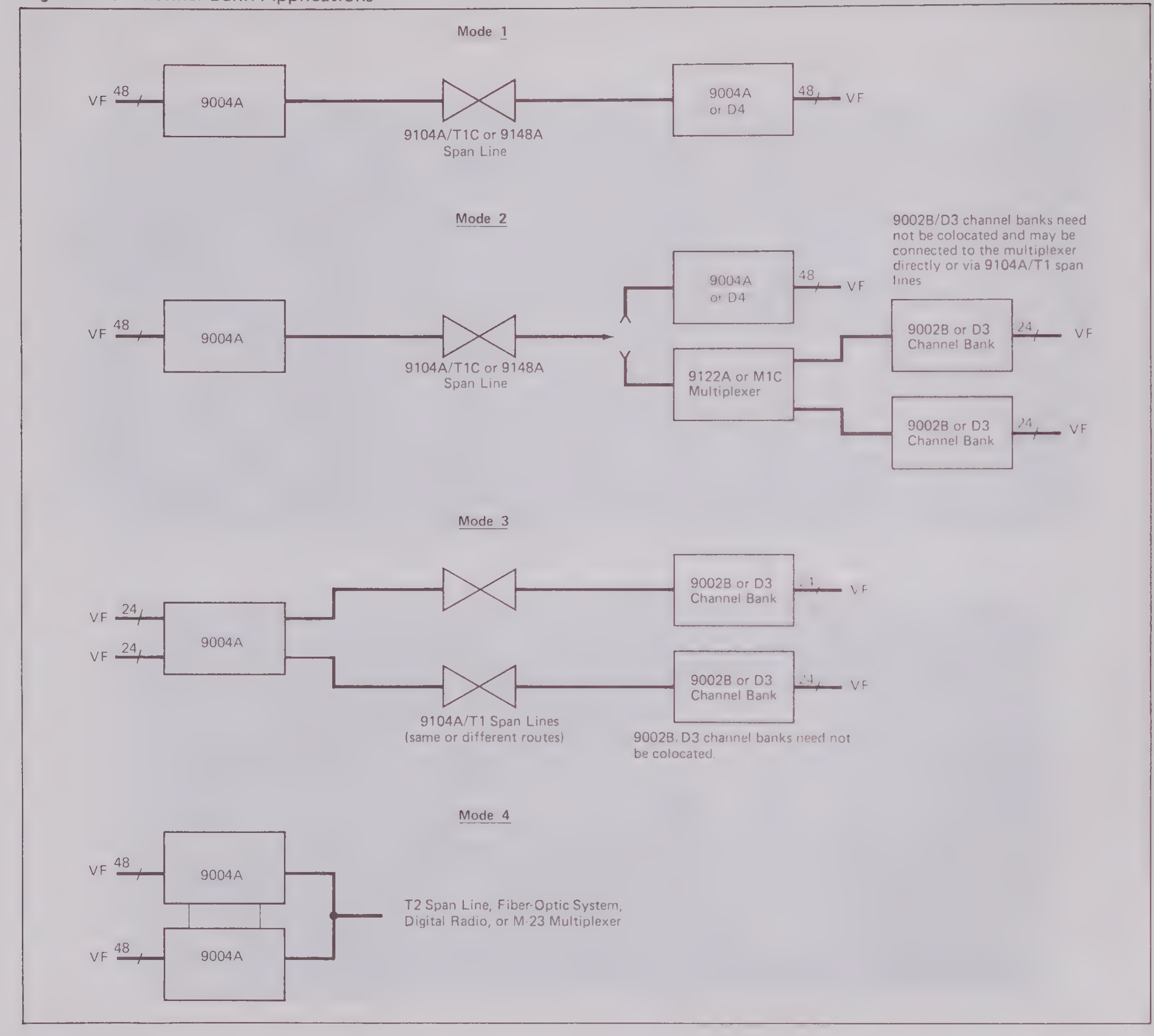
2.07 During one frame, in sequence, the vf signal voltage on each channel is sampled and the amplitude is encoded as an eight-bit word. A framing bit is inserted at the beginning of each frame. This process is repeated 8,000 times per second, making the length of one 24-channel digroup frame 125 μs.

2.08 The eight-bit channel word enables binary encoding of 256 discrete values ($2^8 = 256$). Accordingly, sample voltages are compared against a 256-step voltage curve. This process is known as quantizing and is equivalent in mathematics to rounding off to the nearest whole number. To maintain uniformly low distortion over a wide range of talker volumes, the curve has a compression characteristic with small steps at low levels and larger steps at higher levels.

2.09 In a 12-frame interval called a superframe, the least significant bit of the voice-encoded signal (bit 8) on each channel is replaced by an A signaling bit in frame 6 and a B signaling bit in frame 12. On some channel units, both bits represent the same condition; on others the A signaling bit carries on-hook information and the B signaling bit represents another condition, such as silent/ringing.

2.10 Digroup Frame, Mode 2 or 3. See figure 2-4A. In each frame, there are 192 pcm bits (24 eight-bit channel

Figure 2-3. Channel Bank Applications


Mode 1
VF
48
9004A
9104A/T1C or 9148A
Span Line
9004A
or D4
48
VF
Mode 2
VF
48
9004A
9104A/T1C or 9148A
Span Line
9004A
or D4
48
VF
9122A or M1C
Multiplexer
9002B or D3
Channel Bank
24
VF
9002B or D3
Channel Bank
24
VF
9002B/D3 channel banks need not be colocated and may be connected to the multiplexer directly or via 9104A/T1 span lines
Mode 3
VF
24
VF
24
9004A
9002B or D3
Channel Bank
24
VF
9002B or D3
Channel Bank
24
VF
9104A/T1 Span Lines
(same or different routes)
9002B, D3 channel banks need not be colocated.
Mode 4
VF
48
9004A
VF
48
9004A
T2 Span Line, Fiber-Optic System,
Digital Radio, or M-23 Multiplexer

words) plus an added S-bit ("shared" bit) to control terminal framing and signaling frame identification. The terminal framing bits, designated Ft, have a 101010 pattern in odd-numbered frames 1 through 11 of a superframe. The signaling framing bits, designated Fs, have a 001110 pattern in even-numbered frames 2 through 12.

2.11 The sampling rate of 8,000 Hz multiplied by 193 gives the 1.544-Mb/s rate of the mode 2 or mode 3 digroup signal. At this rate, the time slot for a single bit is 648 ns and the length of an eight-bit channel word is 5.18 μs.

2.12 Digroup Frame, Mode 1. See figure 2-4B. The digroup frame in mode 1 is the same as in modes 2 and 3 except that an F-bit (F1, F1, F0, F0) is added preceding the pcm word for channels 1, 7, 13, and 19. The 1100 F-bit pattern is not presently monitored in the 91431 Mode 1 Receive Unit, but is reserved for possible future applications.

2.13 In each frame there are 192 pcm bits plus five control bits. The sampling rate of 8,000 Hz multiplied by 197 gives the 1.576-Mb/s rate of the mode 1 digroup signal. At this rate, the time slot for a single bit is 634 ns and the length of an eight-bit channel word is 5.07 μs. The frame length is 125 μs, the same as in modes 2 and 3.

2.14 Line Signal, Mode 1. The bits from digroup A and digroup B are interleaved to form the double-digroup sequence shown in figure 2-4C. Each bit from digroup A is followed immediately by the corresponding bit from digroup B. Adjacent S-bits have the same phase (1 or 0).

2.15 The sequence of bits formed by the interleaving is processed by a one-bit scrambler in the 91421 Mode 1 Transmit Unit and becomes the transmission line signal.

2.16 Line Signal, Mode 2. The M1C multiframe (figure 2-4D) has 1,272 bits arranged in four 318-bit subframes designated M1, M2, M3, and M4. In turn, the subframe has six segments, each consisting of a control bit followed by 52 data bits. The data bits are selected alternately from digroup A and digroup B (figure 2-4A). In addition, a maximum of two stuffed bits per digroup are inserted in a multiframe to build out the line signal rate to 3.152 Mb/s nominal.

Figure 2-4. Digital Signal Format

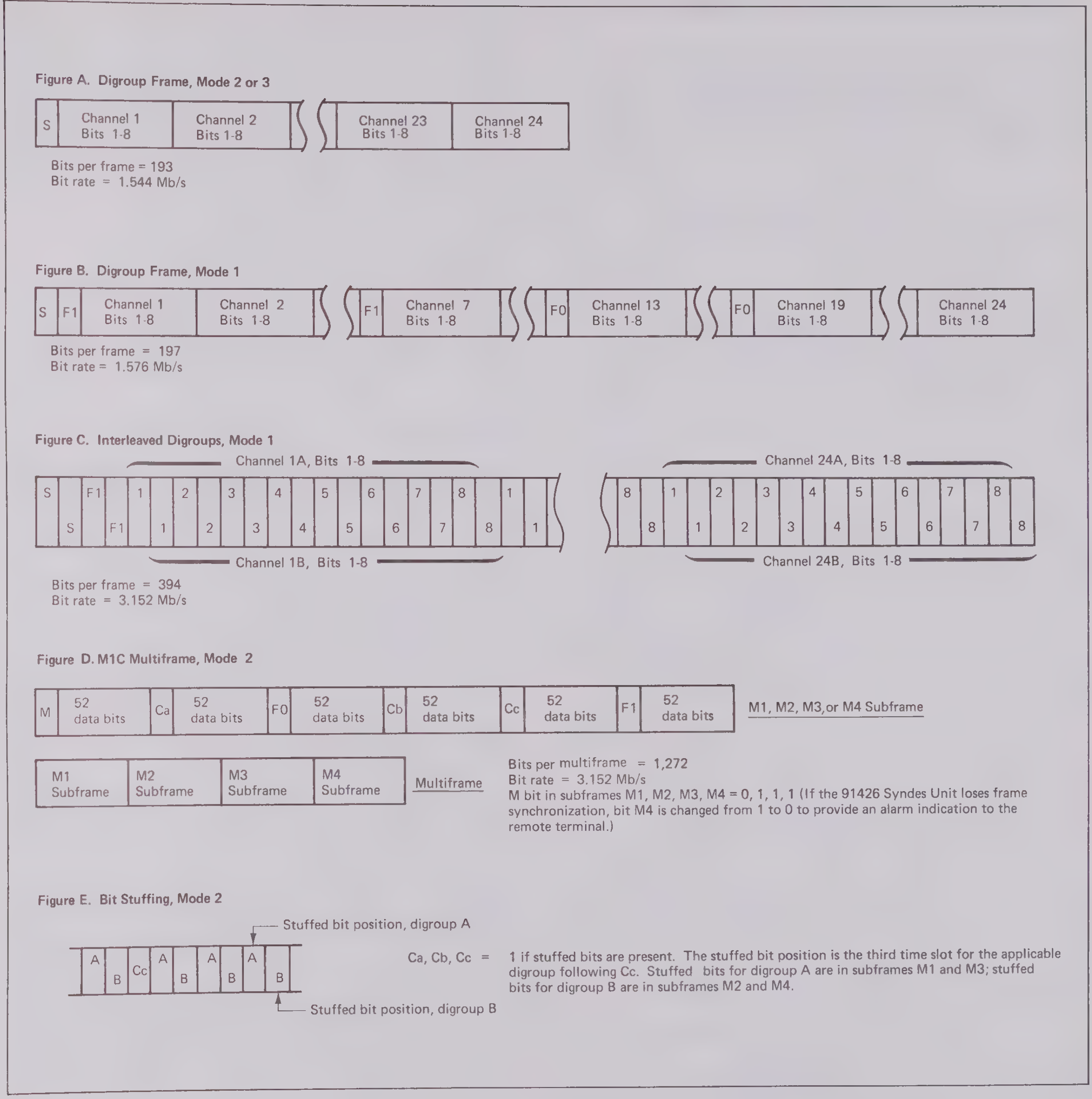

S
Channel 1 Bits 1-8
Channel 2 Bits 1-8
Channel 23 Bits 1-8
Channel 24 Bits 1-8
F1
Channel 7 Bits 1-8
F0
Channel 13 Bits 1-8
Channel 19 Bits 1-8
Channel 1A, Bits 1-8
Channel 1B, Bits 1-8
Channel 24A, Bits 1-8
Channel 24B, Bits 1-8
M
Ca
Cb
Cc
52 data bits
M1 Subframe
M2 Subframe
M3 Subframe
M4 Subframe
A
B
Stuffed bit position, digroup A
Stuffed bit position, digroup B

Figure A. Digroup Frame, Mode 2 or 3

Bits per frame = 193
Bit rate = 1.544 Mb/s

Figure B. Digroup Frame, Mode 1

Bits per frame = 197
Bit rate = 1.576 Mb/s

Figure C. Interleaved Digroups, Mode 1

Bits per frame = 394
Bit rate = 3.152 Mb/s

Figure D. M1C Multiframe, Mode 2

M1, M2, M3, or M4 Subframe

Multiframe

Bits per multiframe = 1,272
Bit rate = 3.152 Mb/s
M bit in subframes M1, M2, M3, M4 = 0, 1, 1, 1 (If the 91426 Syndes Unit loses frame synchronization, bit M4 is changed from 1 to 0 to provide an alarm indication to the remote terminal.)

Figure E. Bit Stuffing, Mode 2

Ca, Cb, Cc = 1 if stuffed bits are present. The stuffed bit position is the third time slot for the applicable digroup following Cc. Stuffed bits for digroup A are in subframes M1 and M3; stuffed bits for digroup B are in subframes M2 and M4.

2.17 In the transmit direction, the digroups are synchronized and there is a correlation between adjacent A and B bits. But in the receive direction, because the signal may have orginated in an M1C multiplexer, the digroups are not necessarily synchronized.

2.18 The combined digroup A and B data, including S-bits, goes through a one-bit scrambler in the 91426 Syndes Unit, after which control bits are inserted as shown in figure 2-4D. The control bits and their functions are described below.

(a) F-Bits. The alternating 1/0 pattern of the F-bits is the basis for frame synchronization in the receive branch of the 91426 Syndes Unit.

(b) M-Bits. The M-bit pattern 011x identifies subframes M1, M2, M3, and M4. The state of the M4 bit (designated "x") is normally transmitted as a 1 but changes to 0 as an out-of-frame indication to the receive terminal.

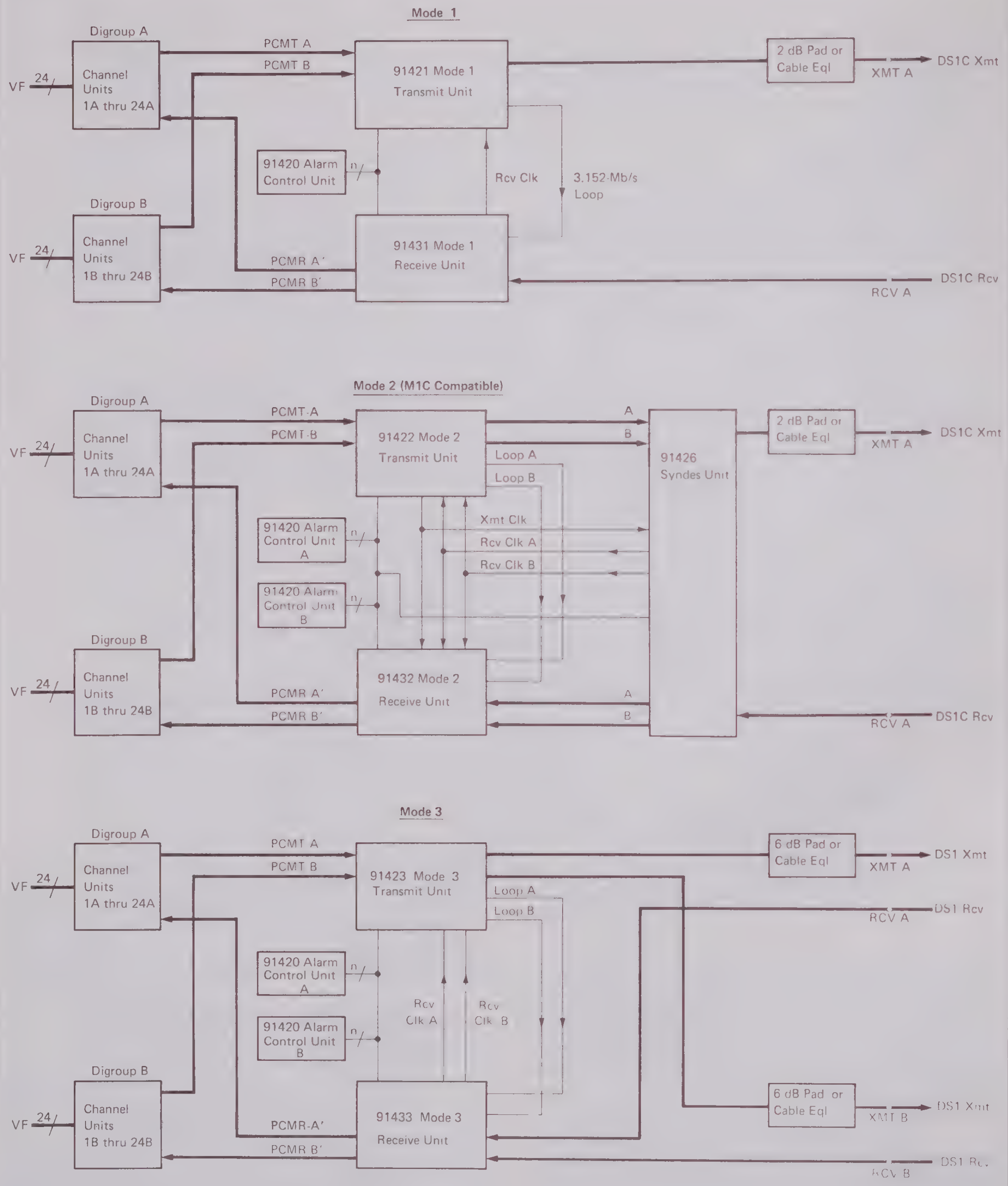
(c) C-Bits. Ca, Cb, and Cc are 0 if the subframe does not contain stuffed bits and 1 if it does. The stuffed position is the third time slot for the applicable digroup following Cc. Refer to figure 2-4E.

2.19 Line Signal, Mode 3. The format of each mode 3 line signal is the same as the digroup signal in figure 2-4A.

Main Signal Flow

2.20 Figure 2-5 is a simplified diagram of the main transmission paths through the channel bank. In all

Figure 2-5. Main Transmission Paths Through the Channel Bank


Mode 1
Digroup A
VF
24
Channel Units 1A thru 24A
PCMT A
PCMT B
91421 Mode 1 Transmit Unit
2 dB Pad or Cable Eql
XMT A
DS1C Xmt
91420 Alarm Control Unit
n
Rcv Clk
3.152-Mb/s Loop
Digroup B
Channel Units 1B thru 24B
PCMR A′
PCMR B′
91431 Mode 1 Receive Unit
DS1C Rcv
RCV A
Mode 2 (M1C Compatible)
Digroup A
Channel Units 1A thru 24A
PCMT-A
PCMT-B
91422 Mode 2 Transmit Unit
A
B
Loop A
Loop B
91426 Syndes Unit
2 dB Pad or Cable Eql
XMT A
DS1C Xmt
91420 Alarm Control Unit A
91420 Alarm Control Unit B
Xmt Clk
Rcv Clk A
Rcv Clk B
Digroup B
Channel Units 1B thru 24B
91432 Mode 2 Receive Unit
PCMR A′
PCMR B′
RCV A
DS1C Rcv
Mode 3
Digroup A
Channel Units 1A thru 24A
PCMT A
PCMT B
91423 Mode 3 Transmit Unit
Loop A
Loop B
6 dB Pad or Cable Eql
XMT A
DS1 Xmt
DS1 Rcv
RCV A
91420 Alarm Control Unit A
91420 Alarm Control Unit B
Rcv Clk A
Rcv Clk B
Digroup B
Channel Units 1B thru 24B
91433 Mode 3 Receive Unit
PCMR-A′
PCMR B′
6 dB Pad or Cable Eql
XMT B
DS1 Xmt
DS1 Rcv
RCV B

Note: n/ denotes multiple input and output leads of the 91420 Alarm Control Unit.

modes, each digroup has a transmit bus (PCMT) and a receive bus (PCMR') over which digital vf and signaling/supervisory information flows serially between the 24 channel units and the transmit unit or receive unit. The transmit unit in all modes supplies one set of timing signals to both digroups; thus, the parallel A and B pcm signals are synchronous. In mode 1, the receive unit supplies one set of timing signals to both digroups; but in modes 2 and 3, the asynchronous A and B pcm signals require independent sets of receive timing signals. The transmit or receive timing signals to the channel units (not shown in figure 2-5) include a clock and 24 channel pulses.

2.21 Mode 1. In the 91421 Mode 1 Transmit Unit, framing bits are added to the synchronized pcm signals from the digroups and the two signals are interleaved and scrambled. The framing format is not M1C compatible. The combined 3.152-Mb/s DS1C signal in bipolar form goes through a shelf-mounted 2-dB pad or cable equalizer to the digital line. For testing, this signal can be looped to the receive unit and a substitute all-1's signal transmitted to the line.

2.22 The 91431 Mode 1 Receive Unit accepts the bipolar 3.152-Mb/s DS1C signal from the digital line, descrambles the signal, and demultiplexes it into two synchronized digroup pcm signals. Framing information and a receive clock are recovered from the incoming signal.

2.23 Mode 2. In the 91422 Mode 2 Transmit Unit, framing bits are added to the two synchronized digroup pcm signals, which exit on separate paths to the 91426 Syndes Unit. There, the signals are interleaved, control bits are added, and the composite signal is scrambled. The 3.152-Mb/s DS1C bipolar output signal goes through a 2-dB pad or cable equalizer to the digital line. The format of this signal is compatible with an M1C multiplexer.

2.24 In the receive direction, the 3.152-Mb/s digital information is descrambled and demultiplexed into two asynchronous digroup pcm signals in the syndes unit. Independent digroup timing and framing information is recovered in the syndes unit and in the 91432 Mode 2 Receive Unit.

2.25 Mode 3. The 91423 Mode 3 Transmit Unit has synchronized parallel through paths and loopback paths for each digroup. Framing bits are added and each 1.544-Mb/s DS1 bipolar signal goes through a shelf-mounted 6-dB pad or cable equalizer to the digital line.

2.26 The 91433 Mode 3 Receive Unit has separate sections for each asynchronous digroup pcm signal. Each section includes independent clock recovery and frame synchronization circuits.

Timing

2.27 Ordinarily, pcm signal timing in a system is independent in each direction of transmission. Transmit timing is controlled by crystal oscillators: 3.152 MHz in mode 1, 3.152 MHz and 1.544 MHz in mode 2, and 1.544 MHz in mode 3. Receive timing is controlled by clock(s) recovered from the incoming pcm signal. Thus, each receive clock is synchronized in frequency with a corresponding transmit clock at the other end of the system.

2.28 In some applications, for example at a digital switching machine interface, the transmit unit is strapped to use the recovered receive clock as a timing source. This is called the "looped receive clock" option. In another option, the transmit timing source is an external clock.

Looped Terminal Status

2.29 With the channel bank in system alarm and the alarm cutoff activated, looped terminal (LT) status is set up by the LOOP pushbutton on the alarm control unit. The digital signal from the transmit unit is looped to the receive unit and an all-1's signal is sent to the line. Both digroups are affected in mode 1, but the digroups can be looped independently in modes 2 and 3.

2.30 In LT status, timing is altered so that channels are linked in pairs with a 12-channel offset. For example, channels 1 and 13 "talk" to each other. Signaling is forced on-hook.

2.31 On a mode 2 channel bank in LT status, momentarily depressing the TEST pushbutton on the syndes unit unloops the 1.544-Mb/s digroup signals and loops the 3.152-Mb/s digital line signal for 300 ms ("fast loop"). If the syndes unit and both digroups in the receive unit reframe on the looped signal, the green PASS indicator lights; otherwise, the red FAIL indicator lights.

Looped Line Status

2.32 Looped line (LL) status is useful in isolating digital line problems. As with LT status, the channel bank must be in system alarm and the alarm cutoff activated. When the TMB HOLD pushbutton on the alarm control unit is depressed, the system alarm and trunk-make-busy conditions are maintained and bit 2 of the outgoing eight-bit channel words is forced to 0. Now, if the digital signal is looped back at a repeater location, the yellow REM indicator lights if the line out and back is good, or the red LOC indicator lights if there is a line fault.

Alarms

2.33 Loss of frame synchronization or receive signal failure lights the red LOC indicator on the alarm control unit. Should the condition last more than 2.5 seconds, the local bank sends an alarm signal to the remote bank by suppressing bit 2 in the outgoing channel words. The remote bank lights the yellow REM indicator and both banks go into a system alarm condition.

2.34 In mode 1, the alarm signal is transmitted in both digroups, although the remote bank monitors digroup B only. In modes 2 and 3, the alarm signal is transmitted in the affected digroup(s).

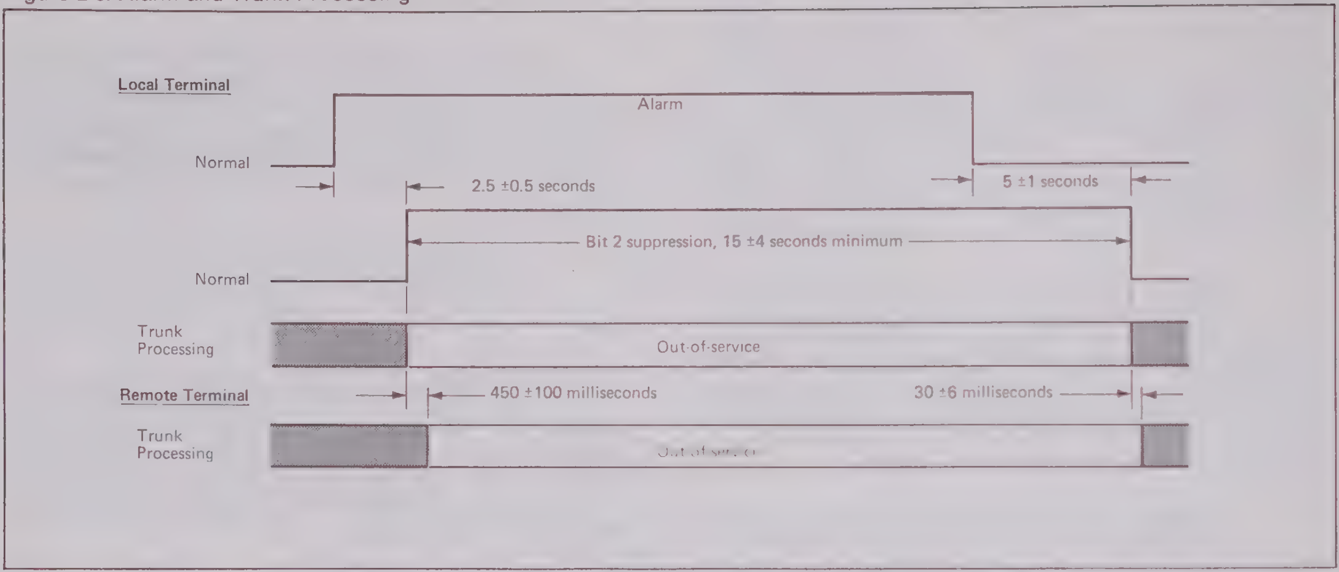
2.35 In mode 2, an out-of-frame condition at the 48-channel, 3.152-Mb/s signal level lights an indicator (red LOCAL or yellow REM, as applicable) on the syndes unit but does not control trunk processing.

Trunk Processing

2.36 When a system failure is detected, an alarm is generated and trunk processing is initiated to remove trunks from service at both ends of the system. When the trouble is cleared, the trunks are returned to service in a coordinated sequence. Trunk processing of the 9004A channel bank is compatible with other pcm channel banks but the timing (figure 2-6) is not necessarily the same. For mode 1 operation, trunk processing removes all 48 channels from service. For mode 2 or 3, only the affected digroup is removed.

2.37 The A and B signaling/supervisory states of each channel are stored in registers, which are updated

Figure 2-6. Alarm and Trunk Processing



during the signaling frames. If an out-of-frame condition is detected, the states that existed about 10 ms earlier are supplied to the channel units. In most cases, this information will not have been contaminated by the disturbance that precipitated reframing. If an in-frame condition is achieved within 2.5 seconds, service will be restored, probably with no change in channel signaling/supervisory status. If framing is not restored within 2.5 seconds, a system alarm takes place and regular trunk processing begins.

Channel Units

2.38 Channel units are available to match two-wire, four-wire, or special-service vf circuits and various types of signaling and supervision. Part 3 includes a general description of channel units and a typical circuit diagram. For details of particular channel unit types, refer to the applicable GTEP Section listed in figure 1-2.

2.39 An important feature of the 9004A channel bank is that each channel unit has its own codec (coder-decoder). The codec makes the transmit analog-to-digital conversion and the receive digital-to-analog conversion at the common equipment interface.

2.40 The single-channel codec has two operational advantages over the common codec of prior equipment. One is that crosstalk is virtually eliminated, and the other is that field adjustment of vf levels is not required. Because the vf circuits and codec are on the same printed circuit board, and because of the codec's internal voltage reference, vf levels can be precisely calibrated at the factory.

3. FUNCTIONAL OPERATION

3.01 Part 3 covers functional operation of the channel bank based on the following circuit diagrams:

Figure	Equipment
3-1 thru 3-6	Terminal equipment shelf
3-7	Channel units (general)
3-12 thru 3-14	Transmit units
3-15 thru 3-17	Receive units
3-20	Syndes unit
3-21	Alarm control unit
3-24	Vf test set
3-25	Test patch panel
3-26	Signaling path test set

Figures 3-1 through 3-6 show external connections and internal wiring of the terminal equipment shelf in six circuit categories. Most of the shelf wiring is part of the printed circuit backplane. The power distribution diagram, figure 3-4, also shows the internal circuits of the 91425 Power Supply Unit and the 91424 Battery Filter Unit.

3.02 In the text and diagrams of this publication, a binary signal that is logic 0 in the activated state is identified by a prime symbol (′) following the signal name. This symbol has the same meaning as the "$\overline{\text{bar}}$" used in other publications; for example TMB1′ and $\overline{\text{TMB1}}$, ChPT-1A′ and $\overline{\text{ChPT-1A}}$, or SigEnBT′ and $\overline{\text{SigEnBT}}$ refer to the same signals.

PCM and Timing Signals

3.03 Figure 3-1 shows the main pcm signal paths (heavy lines), the loopback paths from transmit unit to receive unit, the transmit clock (Xmt Clk) and the receive clocks (Rcv Clk). The configurations of these circuits for modes 1, 2, and 3 are briefly described in Part 2 and appear in simplified form on figure 2-5.

3.04 At the left side of figure 3-1, one channel unit represents the 24 units of the digroup. Connections shown are multipled to all channel units. Each channel unit is connected to a transmit pcm signal bus (PCMT) and a receive pcm signal bus (PCMR′). The transmit unit supplies a transmit clock (ClkT′) to both digroups and the receive unit supplies a receive clock (ClkR-A′ and -B′) on a separate bus to each digroup. Similarly, the transmit unit and receive unit supply SigEnB timing signals to the channel units on three buses.

3.05 The transmit and receive clock buses, ClkT′ and ClkR′, are terminated on each of the four shelf levels by a subassembly 087-56940-01. The termination prevents clock pulse ringing when the shelf is not fully equipped with channel units.

Alarm Circuits

3.06 The 91420 Alarm Control Units on sheet 1 of figure 3-2 have alarm inputs on the left and alarm outputs on the right. Inputs are local alarm (AC1), remote alarm (AC2′), power alarm, and fuse alarms. The input configurations for mode 1 and mode 2 or 3 are shown in figure 3-2A on sheet 2. Outputs are AC3, AC4, AC5′, AC6′, and AC7. External connections to the office alarm equipment are made at J14 and J29, as required.

3.07 Three timing signals associated with trunk processing during a system alarm (TP′, TMB1′, and TMB2′) are supplied to the channel units by the 91420 Alarm Control Units. Signal distribution circuits are set up by the Y/Z strapping plug and, in mode 1, by closed switching contacts on receptacle connector J29 for the unequipped 91420 unit B. Figure 3-2B shows the signal distribution circuits to the channel units in mode 1 and mode 2 or 3.

3.08 With the channel bank in a system alarm or TMB hold condition, and the ACO relay operated, the bank is placed in looped terminal (LT) status by depressing the LOOP pushbutton on either or both 91420 Alarm Control Units. Figure 3-2C gives partial diagrams of the loop control circuits in modes 1, 2, and 3. The looped signals in the three modes are listed below.

Mode	Looped signal
1	Bipolar 3.152-Mb/s
2	Unipolar 1.544-Mb/s
3	Bipolar 1.544-Mb/s

3.09 Referrring to the mode 2 configurations in figure 3-2C, with either digroup in LT status, a loop pulse request (LP Req′) is made by depressing the TEST pushbutton on the 91426 Syndes Unit. In response, the 91420 unit of the digroup in LT status outputs a 300-ms LP′ pulse. The LP′ pulse operates a relay in the 91426 Syndes Unit that loops the DS1C line signal, transmit to receive. The pulse also inhibits gate 1 and/or gate 2 in the transmit unit, unlooping the digroups(s) in the transmit and receive units. For a more detailed explantion, refer to the functional description of the unit involved.

VF and Signaling/Supervisory Circuits

3.10 Vf and signaling/supervisory leads are wired from four pin-pairs on 24 channel units to four 50-pin male connectors, J101-J104 for digroup A and J105-J108 for digroup B. From here, the leads are extended to the office drop equipment via 25-pair cables. Figure 3-3A shows the wiring from one pin-pair on the 24 channel units of a digroup to the associated 50-pin connector. The diagram is typical for pin-pairs 35/36, 37/38, 40/39, and 43/44, which are shown in figures 3-3B and 3-3C. For example, pins 37/38 of channels 1A through 24A are wired to J101; pins 40/39 of channels 1B through 24B are wired to J108.

3.11 Pins 43 and 44 of the channel unit receptacle connectors have switching contacts that are closed when no channel unit is plugged in. Also, a strapping plug is installed to connect pin 42 to pin 44 if the channel unit requires signaling ground on pin 44. Otherwise, the strapping plug is "parked" on pins 41 and 43.

Power Supply and Distribution

3.12 Figure 3-4 shows the 91425 Power Supply Unit, the 91424 Battery Filter Unit, and the distribution of power in the terminal equipment shelf. Entering at terminal TB1-3, power from the −48V office battery is converted by the 91425 unit to +5V, −5V, +12V, and −12V supplies. Office battery is also distributed through the SIG fuses as Sig Bat A and Sig Bat B to digroups A and B.

3.13 When required by DPO and FXS channel units, talking battery from TB1-4 via the A and B TALK fuses is filtered in the 91424 unit and distributed to digroups A and B. If the office does not have talking battery, office battery at TB1-3 is strapped to TB1-4. To prevent blown fuses upon application of power, the surge current is limited by a 33-ohm resistor in the 91424 unit. When the 12,000-μF capacitor is fully charged, relay K1 or K2 operates to short-circuit the resistor and close the supply to the load.

3.14 The 91424 unit also has fuses to protect the 20-Hz ringing supply. If a 2-ampere MASTER fuse blows, the alarm contact is connected to −48V through the 0.18-ampere SLAVE fuse, which then blows. The alarm contact of the SLAVE fuse applies −48V through a 3kΩ resistor to the FA-A′ or FA-B′ fuse alarm lead to the 91420 Alarm Control Unit.

3.15 If the PS fuse blows, the A and B FUSE ALARM indicators light and the FA-A′ and -B′ alarm leads are activated. A blown SIG or TALK fuse affects only the A or B indicator and FA′ lead. The alarm contact on the AUX fuse is not used.

3.16 The Pwr Alm lead from the 91425 Power Supply Unit is connected through a 10kΩ pullup resistor to +5V in the 91420 Alarm Control Unit. In normal condition, the 30-volt zener diode in the 91425 unit conducts, and the voltage on the Pwr Alm lead is at logic 0. If any of the four 91425 output voltages drop below a preset value, transistor Q204 turns on. The red ALM indicator lights, the zener diode cuts off, and the Pwr Alm lead goes to logic 1.

3.17 External rack ground and battery ground connections are made at terminals TB1-1 and TB1-2. If battery ground must be isolated from frame ground, the electrical clip (strap) between TB1-1 and -2 is removed. Within the shelf, TB1-1 is connected to the chassis at one point only, and the battery ground distribution from TB1-2 is floating. Signaling ground has a separate distribution, which is connected to frame ground at TB1-1 only.

Channel Pulse Distribution

3.18 Figure 3-5 diagrams the distribution of transmit and receive channel pulses to channel units 1A and 1B as typical. Connector pin numbers applicable to all channel units are tabulated below the diagram.

3.19 The transmit unit generates one set of 24 transmit channel pulses serving both digroups. The receive unit generates one set of 24 receive channel pulses in mode 1 and two asynchronous sets in modes 2 and 3. For example, ChPR-1A′ and ChPR-1B′ are connected together in the 91431 Mode 1 Receive Unit, but they are separate outputs from the 91432 Mode 2 Receive Unit or the 91433 Mode 3 Receive Unit.

Office Interface Unit

3.20 The 91400 shelf provides wiring from the alarm control units, transmit unit, and receive unit to the future 91448 Office Interface Unit. This wiring plus external alarm and timing signal connections to the 91448 unit are shown in figure 3-6.

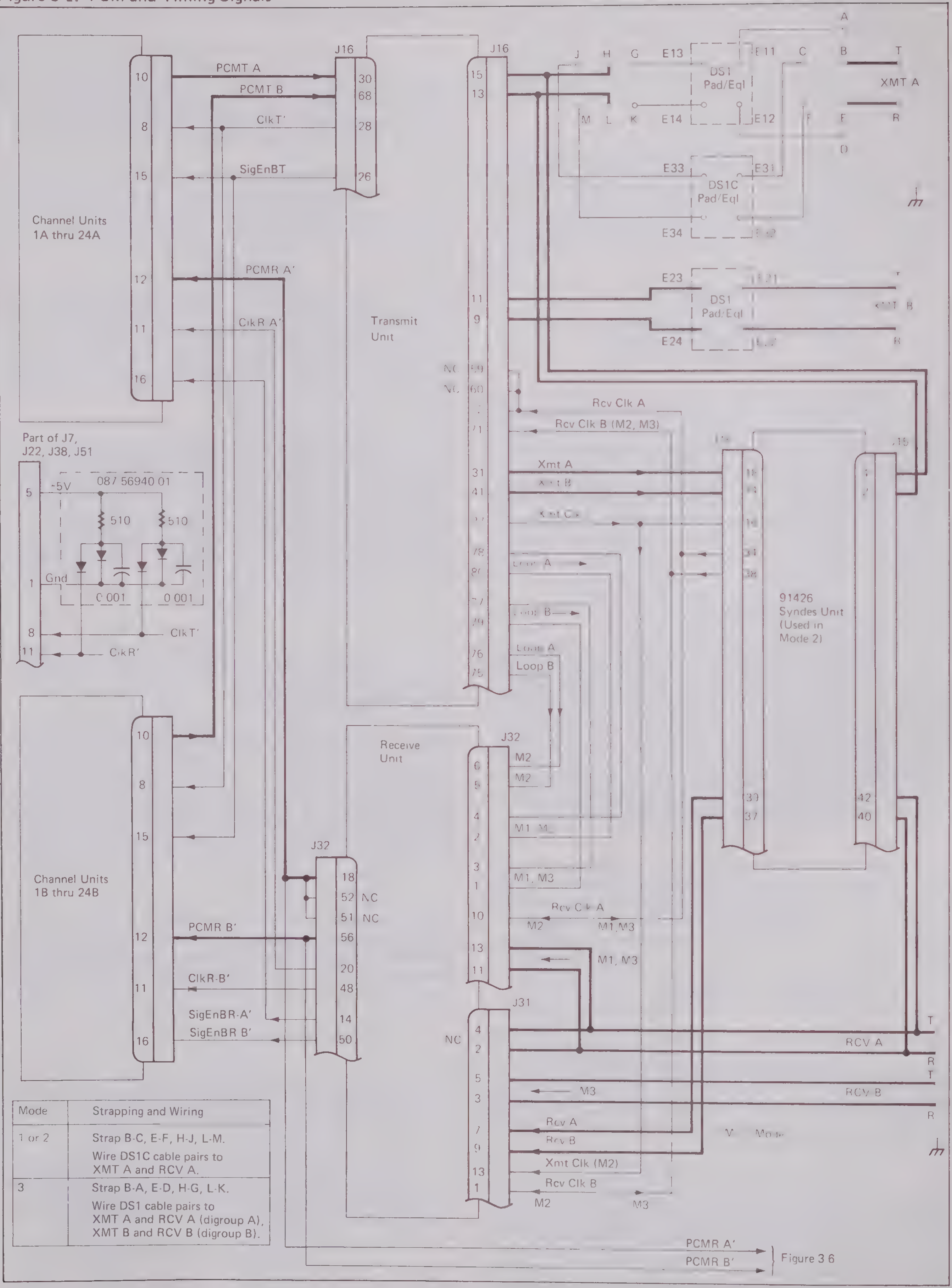
Channel Units

3.21 Figure 3-7 is a generalized diagram of the main transmission paths through a channel unit. Except for the two-wire vs four-wire diffferences, the circuits shown are basically the same for all channel unit types.

3.22 VF Levels. Transmission levels at the vf interface with the office equipment are set by inserting strapping plugs in the transmit and receive attenuators. There are no variable controls to be adjusted and no test points at standard TLP's.

(Text continues on page 23.)

Figure 3-1. PCM and Timing Signals


Channel Units
1A thru 24A
10
8
15
12
11
16
PCMT A
PCMT B
ClkT'
SigEnBT
PCMR A'
ClkR A'
J16
30
68
28
26
Transmit
Unit
J16
15
13
11
9
NC 59
NC 60
71
31
41
78
80
77
79
76
75
Rcv Clk A
Rcv Clk B (M2, M3)
Xmt A
Xmt B
Xmt Clk
Loop A
Loop B
Loop A
Loop B
J
H
G
E13
DS1
Pad/Eql
E11
C
B
T
A
XMT A
M
L
K
E14
E12
F
E
R
D
E33
DS1C
Pad/Eql
E31
E34
E23
DS1
Pad/Eql
XMT B
T
R
E24
J15
18
16
34
38
91426
Syndes Unit
(Used in
Mode 2)
J15
42
40
39
37
Part of J7,
J22, J38, J51
5
-5V
087 56940 01
510
510
1
Gnd
0.001
0.001
8
ClkT'
11
ClkR'
Channel Units
1B thru 24B
10
8
15
12
11
16
PCMR B'
ClkR-B'
SigEnBR-A'
SigEnBR B'
Receive
Unit
J32
18
52 NC
51 NC
56
20
48
14
50
J32
6
5
4
2
3
1
10
13
11
M2
M2
M1 M3
M1, M3
Rcv Clk A
M2
M1, M3
M1, M3
J31
NC
4
2
5
3
7
9
13
1
T
RCV A
R
T
RCV B
R
M3
Rcv A
Rcv B
Xmt Clk (M2)
Rcv Clk B
M2
M3
PCMR A'
PCMR B'
Figure 3 6

Mode	Strapping and Wiring
1 or 2	Strap B-C, E-F, H-J, L-M. Wire DS1C cable pairs to XMT A and RCV A.
3	Strap B-A, E-D, H-G, L-K. Wire DS1 cable pairs to XMT A and RCV A (digroup A), XMT B and RCV B (digroup B).

Figure 3-2. Alarm Circuits (Sheet 1 of 2)

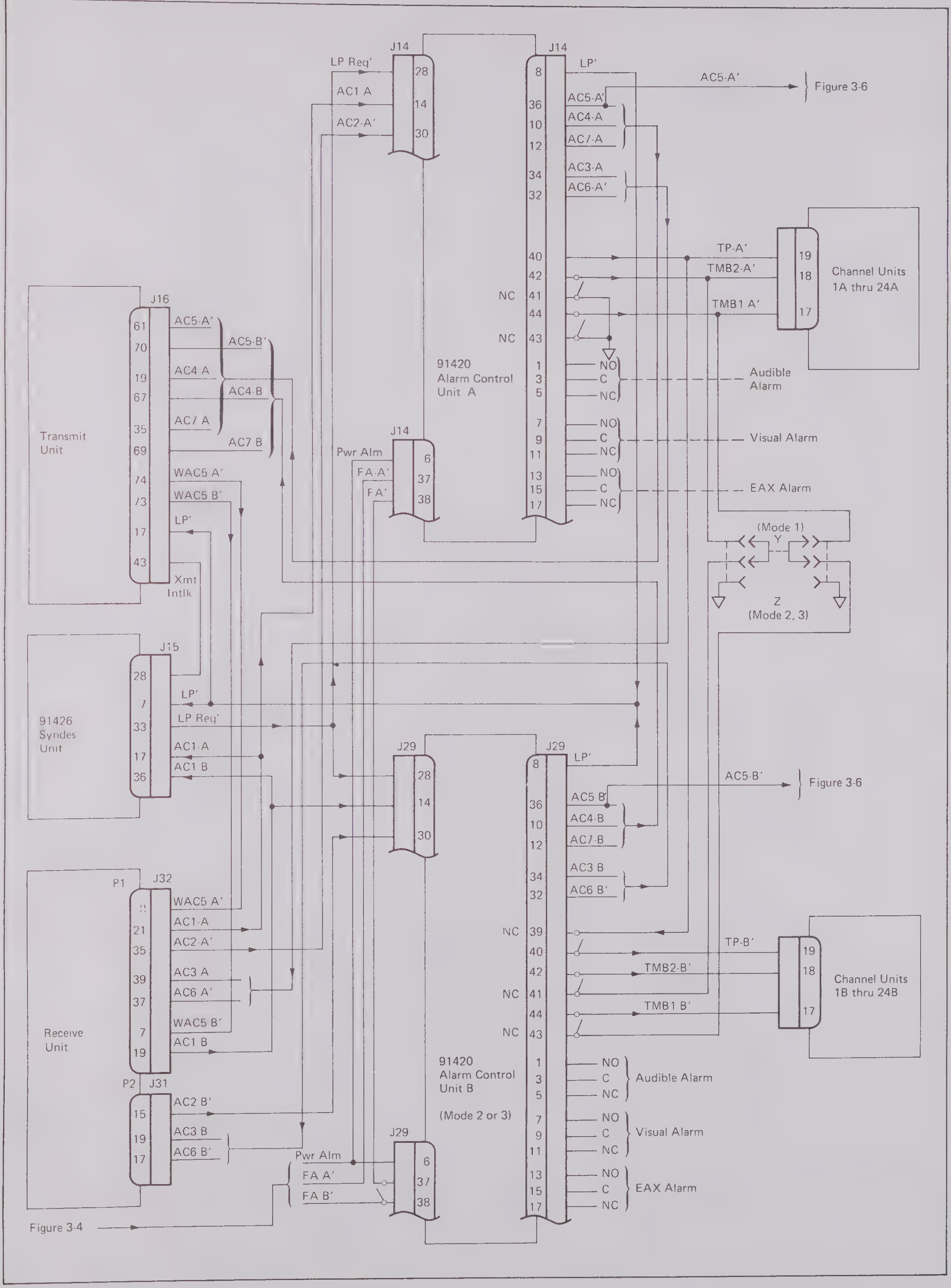

J14
LP Req'
AC1 A
AC2-A'
28
14
30
J14
8
LP'
36
10
12
34
32
AC5-A'
AC4-A
AC7-A
AC3-A
AC6-A'
AC5-A'
Figure 3-6
40
42
NC
41
44
NC
43
TP-A'
TMB2-A'
TMB1 A'
19
18
17
Channel Units
1A thru 24A
91420
Alarm Control
Unit A
1
3
5
NO
C
NC
Audible
Alarm
7
9
11
NO
C
NC
Visual Alarm
13
15
17
NO
C
NC
EAX Alarm
J14
Pwr Alm
FA-A'
FA'
6
37
38
(Mode 1)
Y
Z
(Mode 2, 3)
J16
61
70
19
67
35
69
74
73
17
43
AC5-A'
AC5-B'
AC4 A
AC4-B
AC7 A
AC7 B
WAC5 A'
WAC5 B'
LP'
Xmt
Intlk
Transmit
Unit
J15
28
7
33
17
36
LP'
LP Req'
AC1-A
AC1 B
91426
Syndes
Unit
J29
28
14
30
J29
8
LP'
AC5-B'
Figure 3-6
36
10
12
34
32
AC5 B'
AC4-B
AC7-B
AC3 B
AC6 B'
NC
39
40
42
NC
41
44
NC
43
TP-B'
TMB2-B'
TMB1 B'
19
18
17
Channel Units
1B thru 24B
P1
J32
8
21
35
39
37
7
19
WAC5 A'
AC1-A
AC2-A'
AC3 A
AC6 A'
WAC5 B'
AC1 B
Receive
Unit
P2
J31
15
19
17
AC2 B'
AC3 B
AC6 B'
91420
Alarm Control
Unit B
(Mode 2 or 3)
1
3
5
NO
C
NC
Audible Alarm
7
9
11
NO
C
NC
Visual Alarm
13
15
17
NO
C
NC
EAX Alarm
J29
Pwr Alm
FA A'
FA B'
6
37
38
Figure 3-4

Figure 3-2. Alarm Circuits (Sheet 2 of 2)

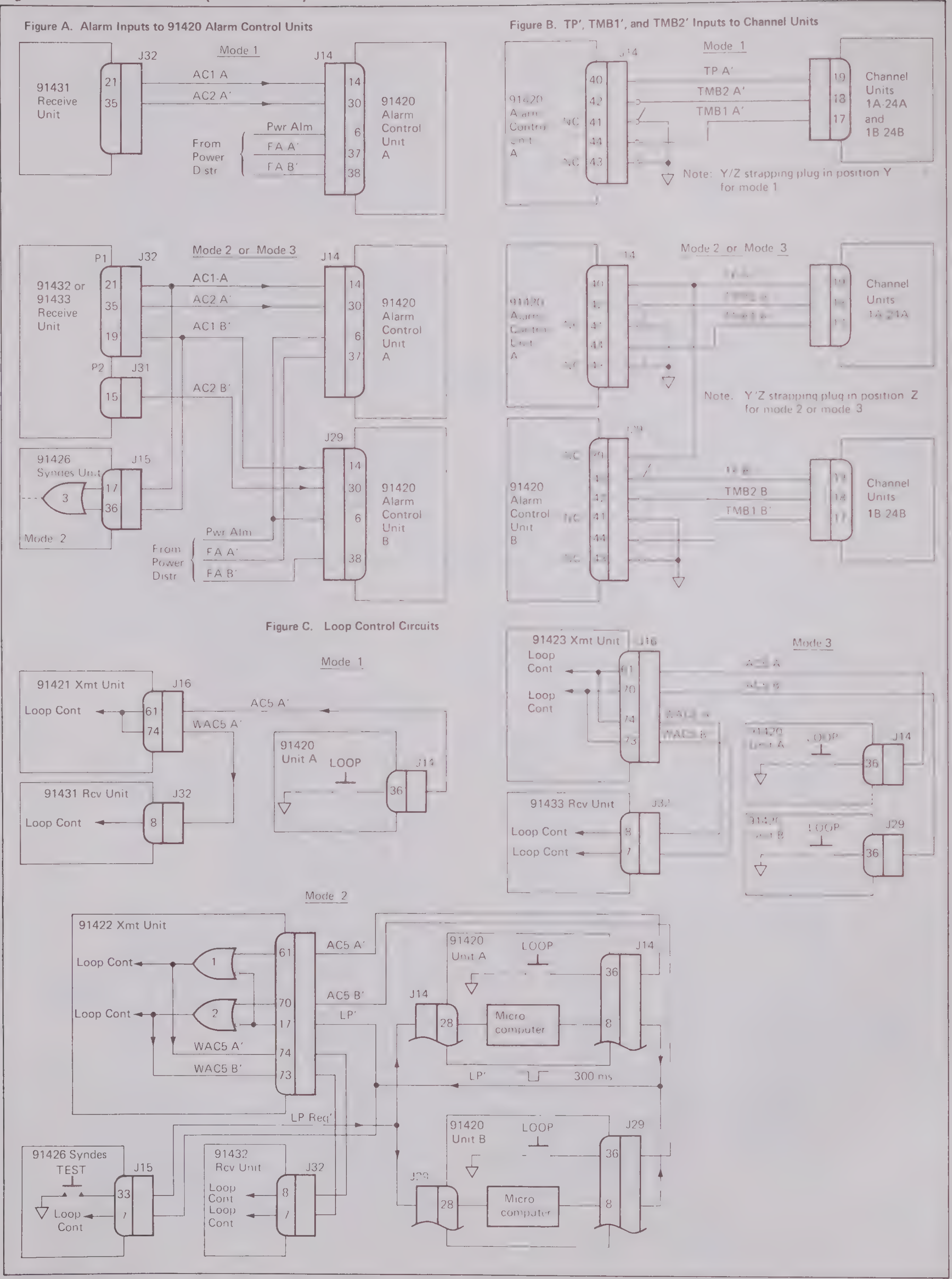


Figure A. Alarm Inputs to 91420 Alarm Control Units

Figure B. TP', TMB1', and TMB2' Inputs to Channel Units

Note: Y/Z strapping plug in position Y for mode 1

Note: Y/Z strapping plug in position Z for mode 2 or mode 3

Figure C. Loop Control Circuits

Mode 1
91431 Receive Unit
J32
21
35
AC1 A
AC2 A'
J14
14
30
6
37
38
91420 Alarm Control Unit A
Pwr Alm
FA A'
FA B'
From Power Distr
Mode 2 or Mode 3
P1
91432 or 91433 Receive Unit
19
AC1-A
AC1 B'
P2
J31
15
AC2 B'
J29
91420 Alarm Control Unit B
91426 Syndes Unit
J15
17
36
3
Mode 2
TP A'
TMB2 A'
TMB1 A'
40
42
41
44
43
NC
Channel Units 1A-24A and 1B-24B
Channel Units 1A-24A
TMB2 B'
TMB1 B'
Channel Units 1B-24B
91421 Xmt Unit
Loop Cont
J16
61
74
AC5 A'
WAC5 A'
91420 Unit A
LOOP
36
91431 Rcv Unit
8
Mode 3
91423 Xmt Unit
70
73
91433 Rcv Unit
7
91420 Unit B
91422 Xmt Unit
1
2
AC5 B'
LP'
WAC5 B'
Micro computer
28
300 ms
LP Req'
91426 Syndes
TEST
33
91432 Rcv Unit

Figure 3-3. VF and Signaling/Supervisory Circuits, External Connections (Sheet 1 of 2)

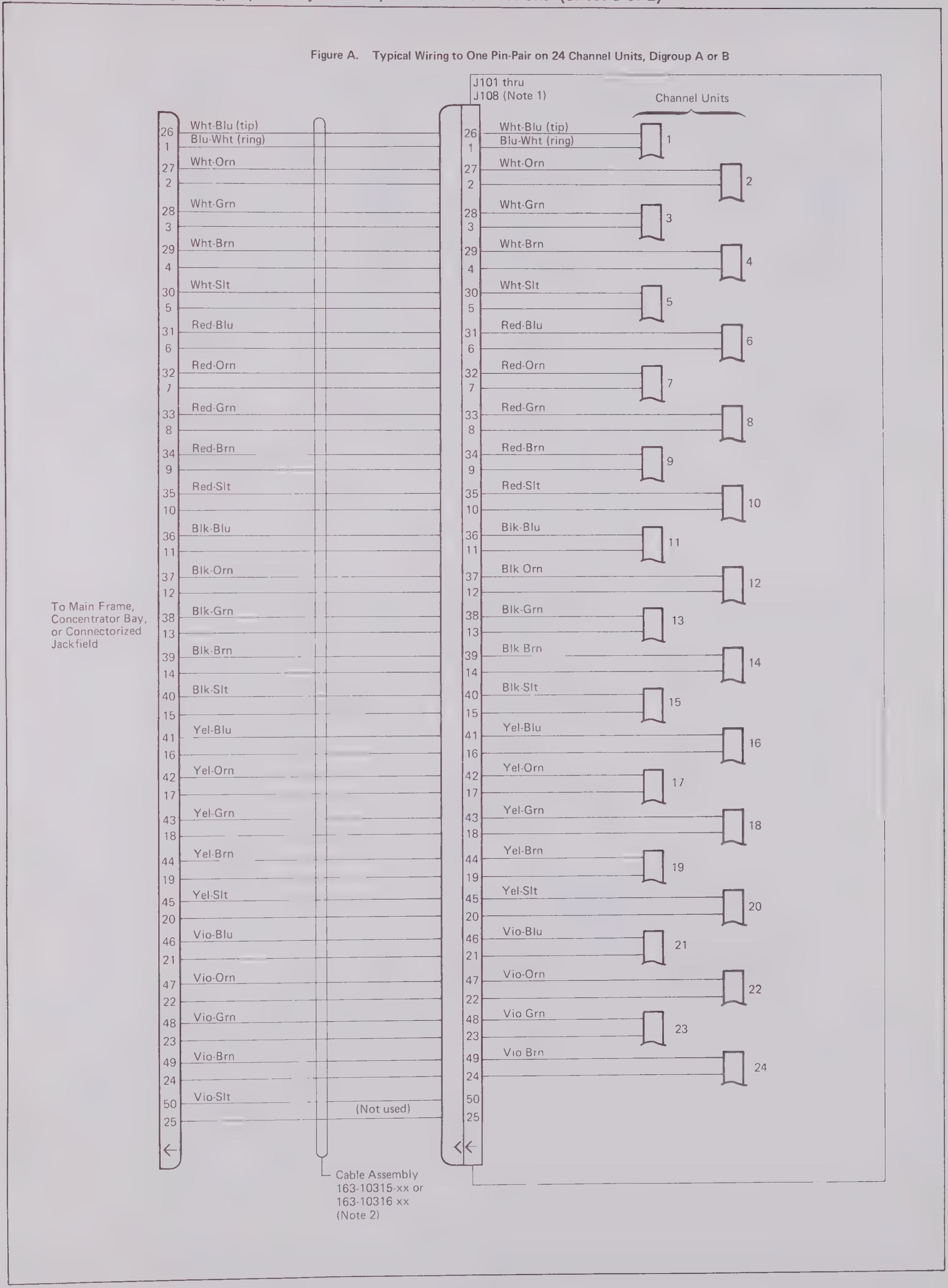


Figure A. Typical Wiring to One Pin-Pair on 24 Channel Units, Digroup A or B
J101 thru
J108 (Note 1)
Channel Units
Wht-Blu (tip)
Blu-Wht (ring)
Wht-Orn
Wht-Grn
Wht-Brn
Wht-Slt
Red-Blu
Red-Orn
Red-Grn
Red-Brn
Red-Slt
Blk-Blu
Blk-Orn
Blk-Grn
Blk-Brn
Blk-Slt
Yel-Blu
Yel-Orn
Yel-Grn
Yel-Brn
Yel-Slt
Vio-Blu
Vio-Orn
Vio-Grn
Vio-Brn
Vio-Slt
(Not used)
To Main Frame, Concentrator Bay, or Connectorized Jackfield
Cable Assembly 163-10315-xx or 163-10316 xx (Note 2)
26 1 27 2 28 3 29 4 30 5 31 6 32 7 33 8 34 9 35 10 36 11 37 12 38 13 39 14 40 15 41 16 42 17 43 18 44 19 45 20 46 21 47 22 48 23 49 24 50 25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Figure 3-3. VF and Signaling/Supervisory Circuits, External Connections (Sheet 2 of 2)

Figure B. Wiring to Channel Unit 1A

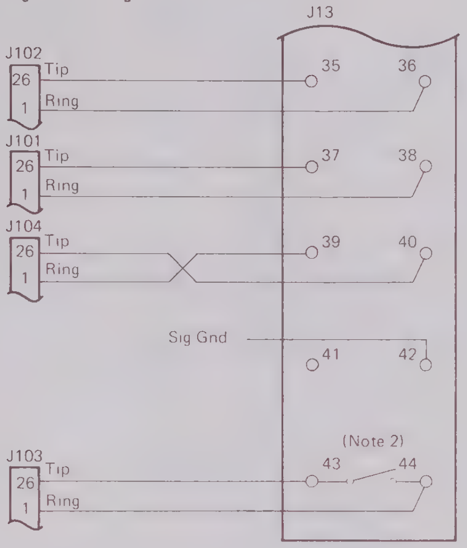
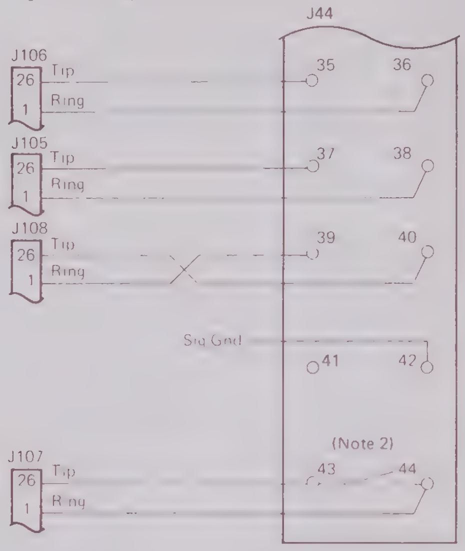

J13
J102
26
1
Tip
Ring
35
36
J101
26
1
Tip
Ring
37
38
J104
26
1
Tip
Ring
39
40
Sig Gnd
41
42
(Note 2)
J103
26
1
Tip
Ring
43
44

Figure C. Wiring to Channel Unit 1B


J44
J106
26
1
Tip
Ring
35
36
J105
26
1
Tip
Ring
37
38
J108
26
1
Tip
Ring
39
40
Sig Gnd
41
42
(Note 2)
J107
26
1
Tip
Ring
43
44

From		J101 or J105		J102 or J106		J103 or J107		J104 or J108	
To Pins on Channel Units 1-24, Tip/Ring		37/	38	35/	36	43	44	40	39
Designations of Leads on Channel Units	91401 4W	T1	R1	T	R				
	91402 2W E&M	T1	R1	A	B	E	SG	SB, F C1	M
	91403 DPO (Note 3)	T1	R1	T1	R1	B1, C, OS, S	B2	EC, PC	ATB
	91404 4W E&M	T1	R1	T	R	E	SG	SB, F C1	M
	91405 DPT	T1	R1			C			
	91407 Tandem	T1	R1	T	R	E1	E2	M2	M1
	91408 FXO	T1	R1			C			
	91409 FXS	T1	R1					RMS	

Notes:

1. External Cabling. At the drop end, Cable Assembly 163-10315-xx is unterminated and Cable Assembly 163-10316-xx is terminated in a male connector as shown.
2. Switching Contacts. Pins 43 and 44 have switching contacts that are closed when no channel unit is plugged in.
3. 91403 DPO Channel Unit. The two-wire port at pins 35 and 36 has nonreversing battery, positive at T1 and negative at R1.

Figure 3-4. Power Supply and Distribution (Sheet 1 of 2)

see adden 2.01

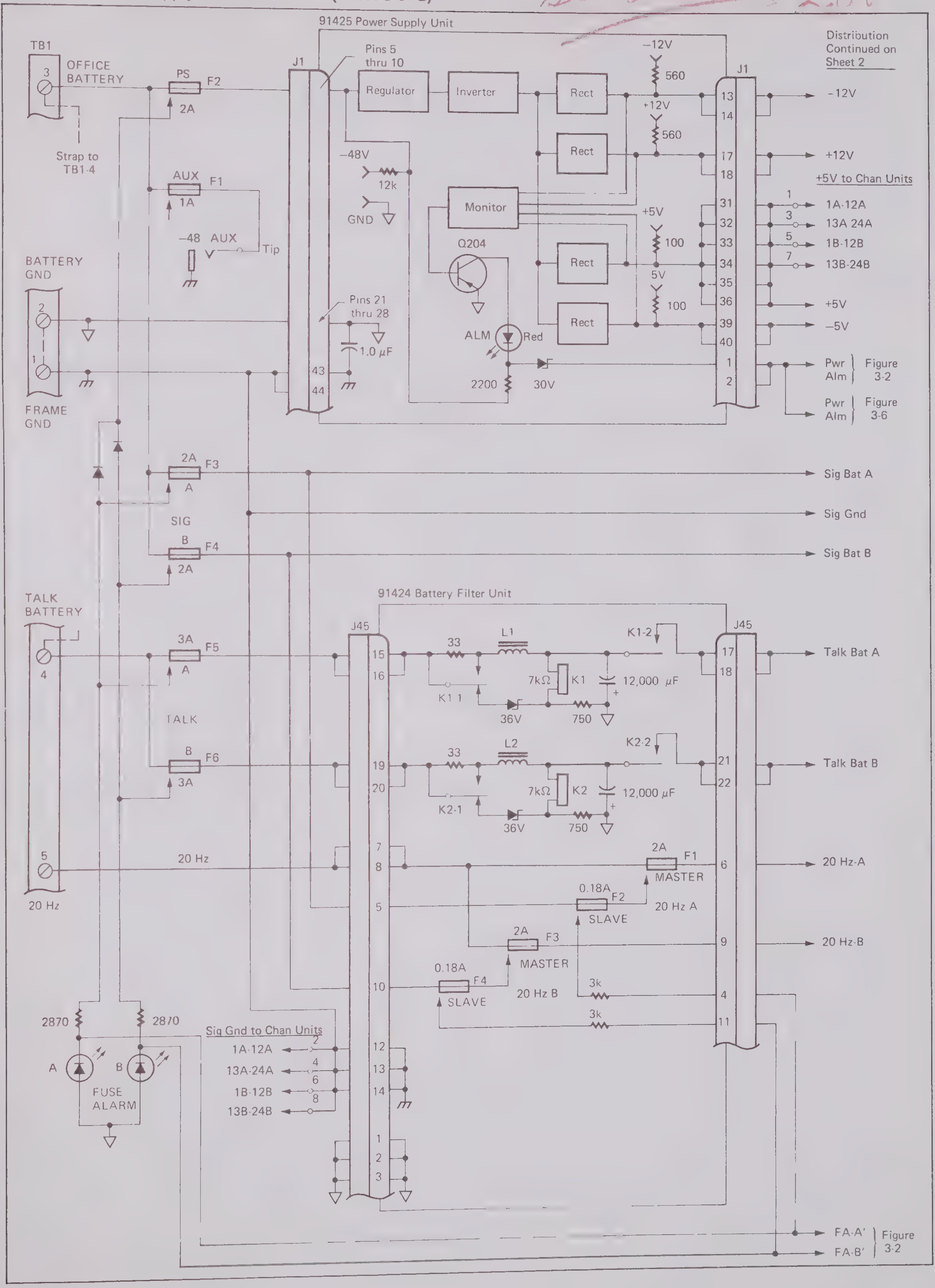

TB1
3
OFFICE BATTERY
Strap to TB1-4
PS
F2
2A
AUX
F1
1A
−48 AUX
Tip
BATTERY GND
2
1
FRAME GND
91425 Power Supply Unit
J1
Pins 5 thru 10
Regulator
Inverter
Rect
Rect
Rect
Rect
Monitor
Q204
ALM
Red
2200
30V
−48V
12k
GND
Pins 21 thru 28
1.0 µF
43
44
−12V
560
+12V
560
+5V
100
5V
100
J1
13
14
17
18
31
32
33
34
35
36
39
40
1
2
Distribution Continued on Sheet 2
−12V
+12V
+5V to Chan Units
1
3
5
7
1A-12A
13A 24A
1B-12B
13B-24B
+5V
−5V
Pwr Alm
Figure 3-2
Pwr Alm
Figure 3-6
2A
F3
A
SIG
B
F4
2A
Sig Bat A
Sig Gnd
Sig Bat B
TALK BATTERY
4
3A
F5
A
TALK
B
F6
3A
5
20 Hz
20 Hz
91424 Battery Filter Unit
J45
15
16
19
20
7
8
5
10
12
13
14
1
2
3
33
L1
K1-2
7kΩ
K1
12,000 µF
K1 1
36V
750
33
L2
K2-2
7kΩ
K2
12,000 µF
K2-1
36V
750
2A
F1
MASTER
0.18A
F2
20 Hz A
SLAVE
2A
F3
MASTER
0.18A
F4
SLAVE
20 Hz B
3k
3k
J45
17
18
21
22
6
9
4
11
Talk Bat A
Talk Bat B
20 Hz-A
20 Hz-B
2870
2870
A
B
FUSE ALARM
Sig Gnd to Chan Units
2
4
6
8
1A-12A
13A-24A
1B-12B
13B-24B
FA-A'
FA-B'
Figure 3-2

Figure 3-4. Power Supply and Distribution (Sheet 2 of 2)

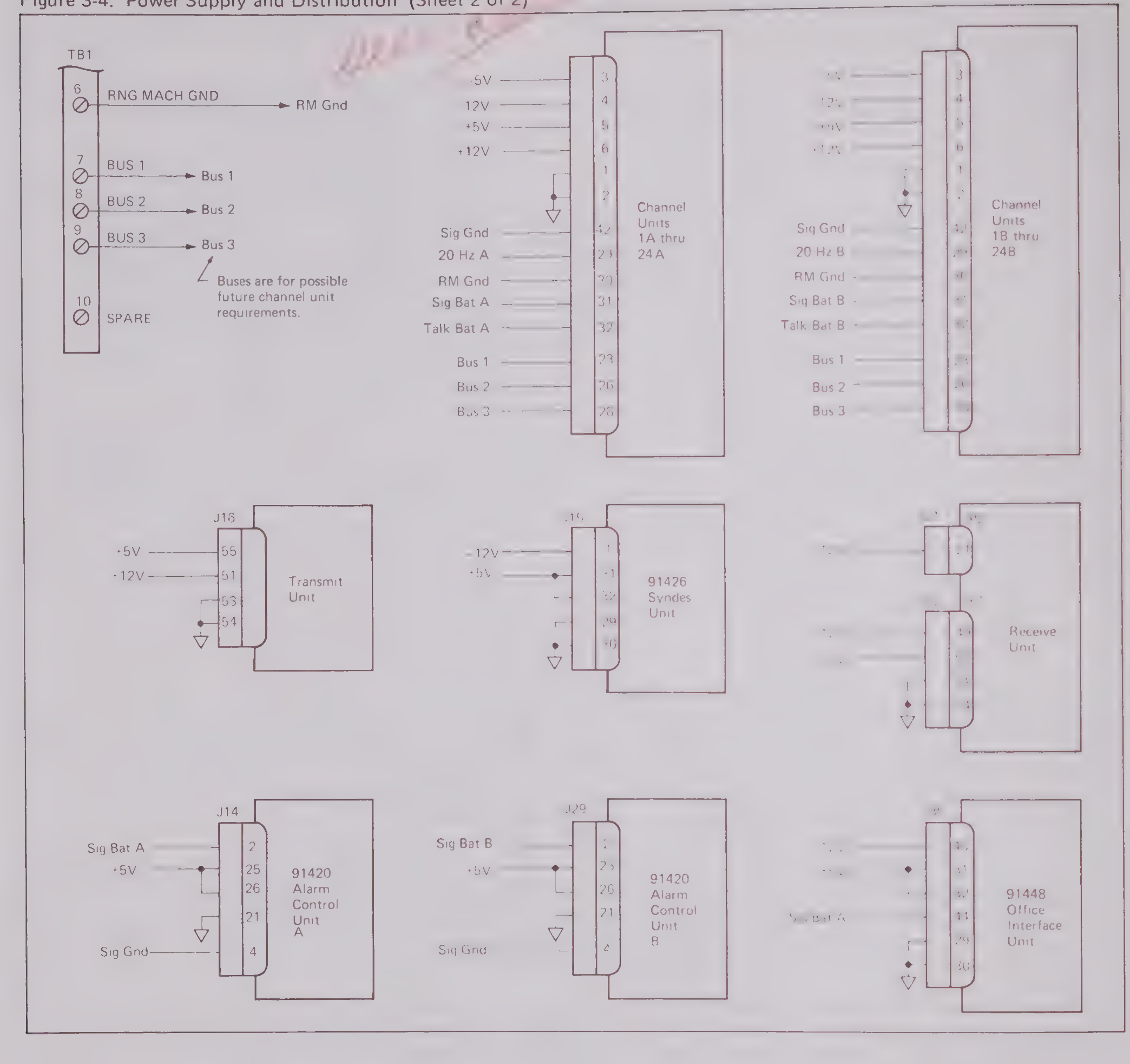
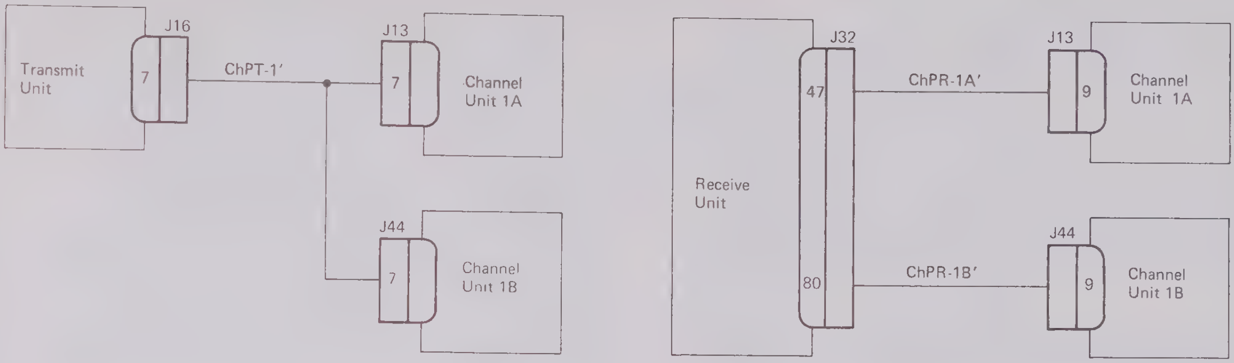

TB1
6 RNG MACH GND
RM Gnd
7 BUS 1
Bus 1
8 BUS 2
Bus 2
9 BUS 3
Bus 3
10 SPARE
Buses are for possible future channel unit requirements.
5V
12V
+5V
+12V
Sig Gnd
20 Hz A
RM Gnd
Sig Bat A
Talk Bat A
Bus 1
Bus 2
Bus 3
3
4
5
6
1
2
42
23
29
31
32
23
26
28
Channel Units 1A thru 24A
Sig Gnd
20 Hz B
RM Gnd
Sig Bat B
Talk Bat B
Bus 1
Bus 2
Bus 3
Channel Units 1B thru 24B
J16
+5V
+12V
55
51
53
54
Transmit Unit
+12V
+5V
1
41
32
29
30
91426 Syndes Unit
Receive Unit
J14
Sig Bat A
+5V
Sig Gnd
2
25
26
21
4
91420 Alarm Control Unit A
J29
Sig Bat B
+5V
Sig Gnd
2
25
26
21
4
91420 Alarm Control Unit B
Sig Bat A
11
29
30
91448 Office Interface Unit

Figure 3-5. Channel Pulse Distribution

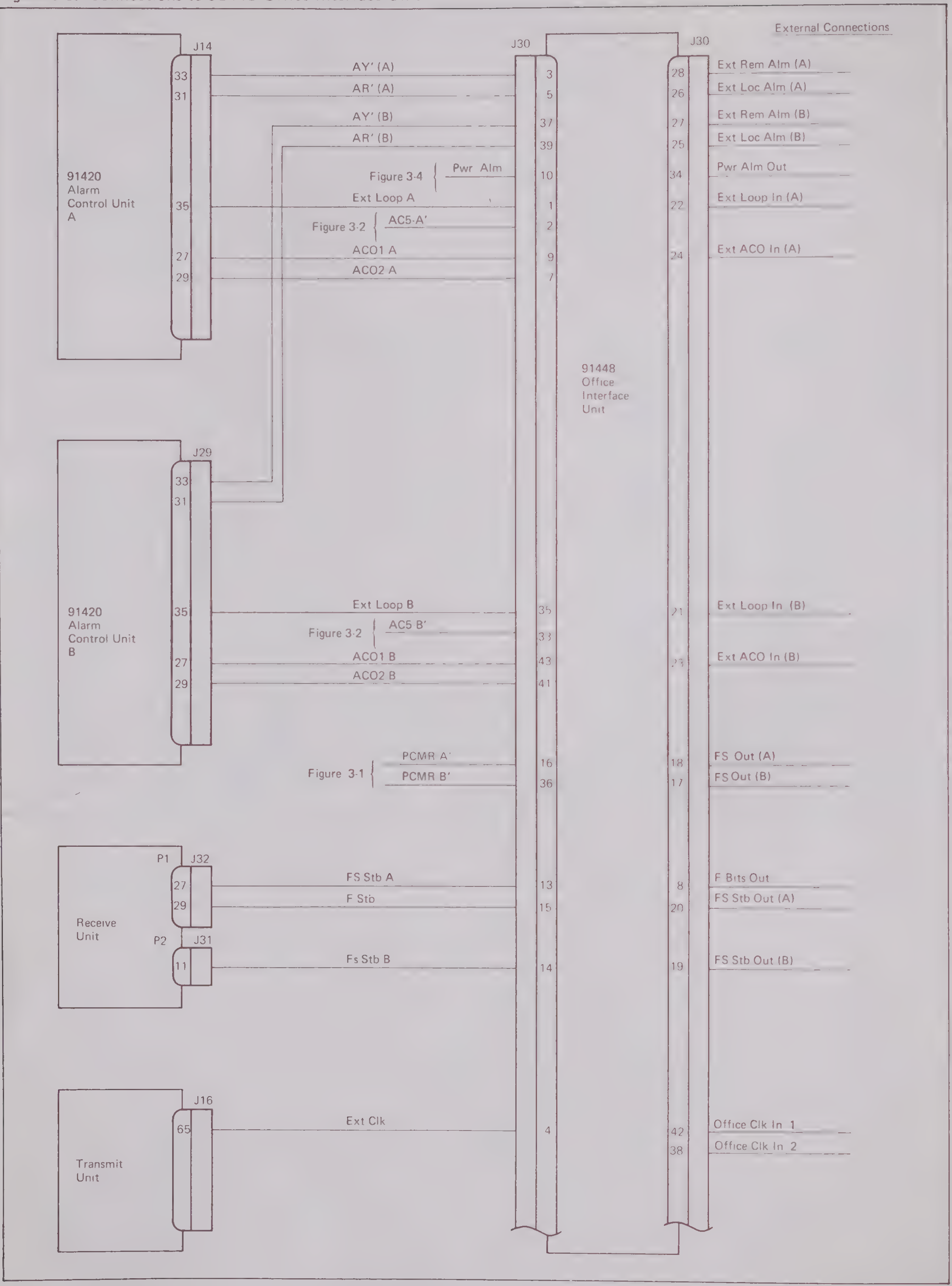

J16
Transmit Unit
7
ChPT-1′
J13
7
Channel Unit 1A
J44
7
Channel Unit 1B
J32
47
80
Receive Unit
ChPR-1A′
ChPR-1B′
J13
9
Channel Unit 1A
J44
9
Channel Unit 1B

Transmit Channel Pulse	From J16 Pin	To Pin 7 of	
		Jx (Chan)	Jy (Chan)
CnPT 1′	7	J13 (1A)	J44 (1B)
2′	5	J12 (2A)	J43 (2B)
3	3	J11 (3A)	J42 (3B)
4′	1	J10 (4A)	J41 (4B)
5′	4	J9 (5A)	J40 (5B)
6′	2	J8 (6A)	J39 (6B)
7	6	J7 (7A)	J38 (7B)
8	8	J6 (8A)	J37 (8B)
9′	10	J5 (9A)	J36 (9B)
10′	12	J4 (10A)	J35 (10B)
11′	14	J3 (11A)	J34 (11B)
12′	16	J2 (12A)	J33 (12B)
13′	58	J28 (13A)	J57 (13B)
14′	52	J27 (14A)	J56 (14B)
15′	50	J26 (15A)	J55 (15B)
16′	48	J25 (16A)	J54 (16B)
17′	46	J24 (17A)	J53 (17B)
18′	44	J23 (18A)	J52 (18B)
19′	42	J22 (19A)	J51 (19B)
20′	40	J21 (20A)	J50 (20B)
21′	38	J20 (21A)	J49 (21B)
22	36	J29 (22A)	J48 (22B)
23′	34	J18 (23A)	J47 (23B)
24′	32	J17 (24A)	J46 (24B)

Receive Channel Pulse	From J32 Pin	To Pin 9 of Jx (Chan)
ChPR-1A′	47	J13 (1A)
-2A′	45	J12 (2A)
-3A′	43	J11 (3A)
-4A′	44	J10 (4A)
-5A′	41	J9 (5A)
-6A′	33	J8 (6A)
-7A′	31	J7 (7A)
-8A′	25	J6 (8A)
-9A′	23	J5 (9A)
-10A′	17	J4 (10A)
-11A′	15	J3 (11A)
-12A′	9	J2 (12A)
-13A′	42	J28 (13A)
-14A′	40	J27 (14A)
15A′	38	J26 (15A)
-16A′	36	J25 (16A)
-17A′	34	J24 (17A)
-18A′	32	J23 (18A)
-19A′	30	J22 (19A)
-20A′	28	J21 (20A)
-21A′	26	J20 (21A)
-22A′	24	J19 (22A)
-23A′	22	J18 (23A)
-24A′	16	J17 (24A)

Receive Channel Pulse	From J32 Pin	To Pin 9 of Jy (Chan)
ChPR-1B′	80	J44 (1B)
-2B′	78	J43 (2B)
-3B′	76	J42 (3B)
-4B′	74	J41 (4B)
-5B′	72	J40 (5B)
-6B′	70	J39 (6B)
-7B′	68	J38 (7B)
-8B′	66	J37 (8B)
-9B′	64	J36 (9B)
-10B′	62	J35 (10B)
-11B′	60	J34 (11B)
-12B′	46	J33 (12B)
-13B′	57	J57 (13B)
-14B′	59	J56 (14B)
-15B′	61	J55 (15B)
-16B′	63	J54 (16B)
-17B′	65	J53 (17B)
-18B′	67	J52 (18B)
-19B′	69	J51 (19B)
-20B′	71	J50 (20B)
-21B′	73	J49 (21B)
-22B′	75	J48 (22B)
-23B′	77	J47 (23B)
-24B′	79	J46 (24B)

Figure 3-6. Connections to 91448 Office Interface Unit


External Connections
J14
J30
J30
91420
Alarm
Control Unit
A
33
31
35
27
29
AY' (A)
AR' (A)
AY' (B)
AR' (B)
Figure 3-4
Pwr Alm
Ext Loop A
Figure 3-2
AC5-A'
ACO1 A
ACO2 A
3
5
37
39
10
1
2
9
7
28
26
27
25
34
22
24
Ext Rem Alm (A)
Ext Loc Alm (A)
Ext Rem Alm (B)
Ext Loc Alm (B)
Pwr Alm Out
Ext Loop In (A)
Ext ACO In (A)
91448
Office
Interface
Unit
J29
91420
Alarm
Control Unit
B
33
31
35
27
29
Ext Loop B
Figure 3-2
AC5 B'
ACO1 B
ACO2 B
35
33
43
41
21
23
Ext Loop In (B)
Ext ACO In (B)
Figure 3-1
PCMR A'
PCMR B'
16
36
18
17
FS Out (A)
FS Out (B)
Receive
Unit
P1
J32
27
29
P2
J31
11
FS Stb A
F Stb
Fs Stb B
13
15
14
8
20
19
F Bits Out
FS Stb Out (A)
FS Stb Out (B)
Transmit
Unit
J16
65
Ext Clk
4
42
38
Office Clk In 1
Office Clk In 2

(Continued from page 13.)

3.23 For the ordinary nontandem applications of a four-wire channel unit, the transmit/receive drop levels are set at – 16/ + 7 dBm by strapping the tandem attenuators for 0 dB and the 6.3-dB step attenuators for 1.5 dB. From these setting, in 0.1-dB steps, the step attenuators can be decreased 1.5 dB to compensate for office loss or increased 4.8 dB to adjust insertion loss. The adjustment ranges at each setting of the tandem attenuators are summarized in figure 3-8.

3.24 Figure 3-9 compares vf levels in four-wire channel units of the 9002B and 9004A channel banks. Assuming 0.3 dB office loss, the transmit and receive attenuators on the channel units are set at 1.2 dB to obtain – 16/ + 7 TLP's at the toll test board. (The attenuator setting for 0 dB office loss is 1.5 dB as mentioned in the preceding paragraph.) A test setup with a 9002B channel unit and two test setups with a 9004A channel unit are shown in figure 3-9 and described below. For end-to-end testing, the same setup at each terminal is required.

(a) In the first setup with a 9002B channel unit, the 91232 test set outputs 1025-Hz tone at – 16 dBm, which coordinates with the – 16 TLP at the 4W XMT CARR jack. The receive level at the 4W RCV CARR jack measures + 7 dBm on the acvm.

(b) The 91232 test set is also used to test a 9004A channel unit as shown in the second setup. Here, the tone goes through the transmit and receive attenuators set at 1.2 dB, and the four-wire receive level measures + 7.6 dBm.

(c) The third setup tests a 9004A channel unit with a 91442 VF Test Set. Setting the test set attenuators at 1.2 dB compensates for the channel unit attenuators, and the acvm reads 0 dB as a normal indication.

3.25 On two-wire trunk channel units, for 0 dB office loss and 0/ – 3 TLP's at the drop, the 6.3-dB step attenuators are set at 4.5 dB transmit and 3.0 dB receive. By strapping the attenuators, vf drop levels are adjustable in 0.1-dB steps within the following ranges.

(a) Transmit: – 4.5 to + 1.8 dBm
(b) Receive: 0 to – 6.3 dBm

3.26 On foreign-exchange channel units, the step attenuators have an additional 6.4-dB section that gives the following vf drop level adjustment ranges.

(a) Transmit: – 10.9 to + 1.8 dBm
(b) Receive: + 2 to – 10.7 dBm

3.27 Figure 3-7A shows a six-section 6.3-dB step attenuator, transmit or receive, strapped for 1.5 dB. A strapping plug must be inserted in the IN or OUT position of each section. Figure 3-7B shows the transmit and receive tandem attenuators strapped for 0 dB. A strapping plug must be inserted in one of the four positions of a tandem attenuator.

3.28 Hybrid. Figure 3-7C shows a typical configuration of the bridge circuit that serves as a two-wire to four-wire hybrid on two-wire channel units. The bridge is balanced by an internal compromise network or, on foreign-exchange channel units, by one of several optional precision networks. These special internal precision networks, designed for particular gauges and loading arrangements of the vf cables, are strapped to improve balance over the channel frequency range. No provision is made for connection to external precision networks.

3.29 Through strapping plugs, six network buildout (NBO) capacitors can be paralleled to compensate for 0 to 0.126 μF office wiring capacitance in 0.002-μF (2-nanofarad) steps. See figure 3-7D.

3.30 Hybrid performance is rated by transhybrid loss and return loss; for either parameter, higher loss (dB) means better performance. Transhybrid loss and various forms of return loss are defined as follows.

(a) Transhybrid loss: measure of the signal loss from the four-wire receive port of the hybrid to the four-wire transmit port. It is equal to the sum of the four-wire return loss, the four-wire to two-wire receive insertion loss, and the two-wire to four-wire transmit insertion loss.

(b) Four-wire return loss: measure of the impedance match between the two-wire drop and the balancing network.

(c) Two-wire return loss: measure of the impedance match between a reference impedance and the impedance looking into the hybrid two-wire port. It is affected by the impedances at the four-wire transmit and receive ports but not the impedance of the balancing network.

(d) Echo return loss (ERL) and singing return loss (SRL): measure of the reflected energy at the near-end two-wire port plus any transhybrid energy returned from the far-end four-wire transmit port.

  (1) ERL is the average weighted loss in the 500-2500 Hz band.

  (2) SRL is the average weighted loss in the singing bands, 200-500 Hz and 2500-3200 Hz.

3.31 Filters. Channel unit vf filters are active types. In the transmit branch, the highpass and lowpass filters create a nominal passband of 180 to 3400 Hz with rolloff to – 20 dB at the 60-Hz power line frequency. The receive lowpass filter, which has a 3400-Hz cutoff, reconstructs the vf signal from the stepped output of the decoder while blocking the 8-kHz sampling frequency and other out-of-band components.

3.32 Codec. Each channel unit has an integrated-circuit codec (coder-decoder) with an internal voltage reference. In the transmit direction, during an assigned time slot, the coder samples the vf signal and converts the analog voltage into an eight-bit pcm digital word. After a one-frame delay, the coder outputs the eight bits serially to the transmit pcm bus (PCMT). This process is repeated at an 8,000-Hz frame rate. In frames 6 and 12 of a 12-frame interval called a superframe, the vf information in the least significant bit (bit 8) is suppressed and bit 8 conveys the channel signaling/supervisory status.

3.33 In the receive direction, the decoder performs a reciprocal function. During an assigned time slot, the channel word is clocked in from the receive pcm bus (PCMR′) and converted to the sample voltage that was encoded by the far-end channel unit. From these discrete voltage steps, the lowpass filter reconstructs the original analog signal. Signaling bit 8 is latched in the decoder and updated each signaling frame.

3.34 Quantization. Figure 3-10 is a curve representing quantization of sample voltages by the coder. This

Figure 3-7. Channel Unit Circuit Diagram, Generalized Form

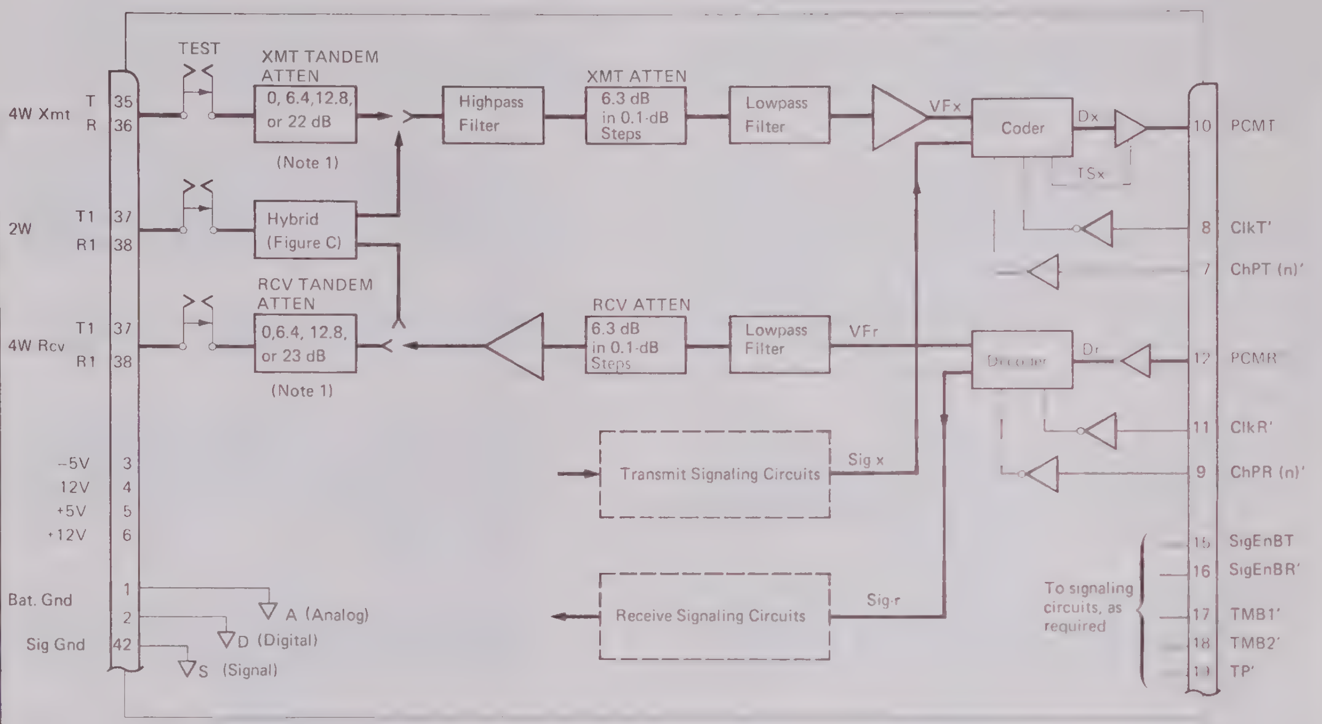

4W Xmt
T 35
R 36
TEST
XMT TANDEM ATTEN
0, 6.4,12.8, or 22 dB
(Note 1)
Highpass Filter
XMT ATTEN
6.3 dB in 0.1-dB Steps
Lowpass Filter
VFx
Coder
Dx
TSx
10 PCMT
2W
T1 37
R1 38
Hybrid (Figure C)
8 ClkT'
7 ChPT (n)'
RCV TANDEM ATTEN
4W Rcv
T1 37
R1 38
0,6.4, 12.8, or 23 dB
(Note 1)
RCV ATTEN
6.3 dB in 0.1-dB Steps
Lowpass Filter
VFr
Decoder
Dr
12 PCMR
11 ClkR'
9 ChPR (n)'
-5V 3
12V 4
+5V 5
+12V 6
Transmit Signaling Circuits
Sig x
Receive Signaling Circuits
Sig r
15 SigEnBT
16 SigEnBR'
To signaling circuits, as required
17 TMB1'
18 TMB2'
19 TP'
Bat. Gnd 1
2
Sig Gnd 42
A (Analog)
D (Digital)
S (Signal)

Figure A. 6.3-dB Step Attenuator Strapped for 1.5 dB

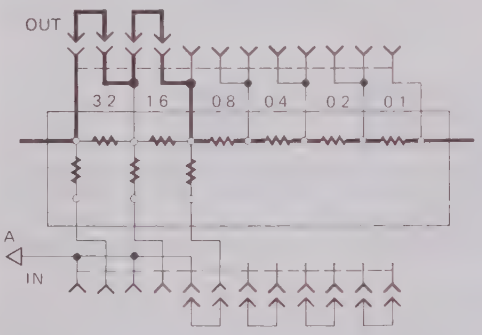

OUT
3 2
1 6
0 8
0 4
0 2
0 1
A
IN

Figure C Two Wire Four Wire Hybrid Circuit

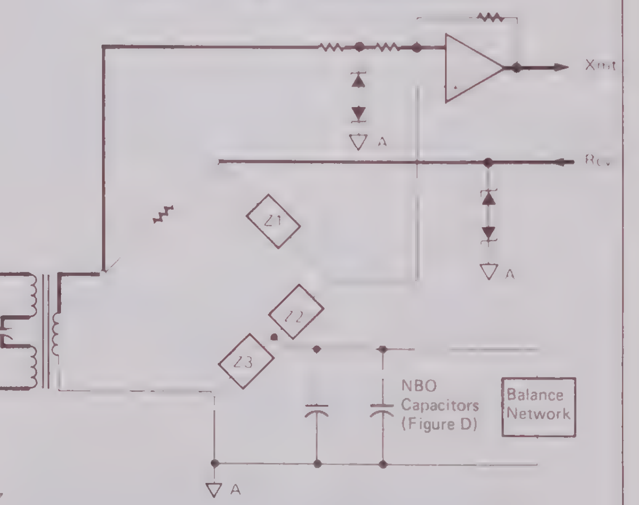

Xmt
A
Rcv
Z1
A
Z2
2W
Z3
NBO Capacitors (Figure D)
Balance Network
A

Figure B. Tandem Attenuator Strapped for 0 dB (Note 1)

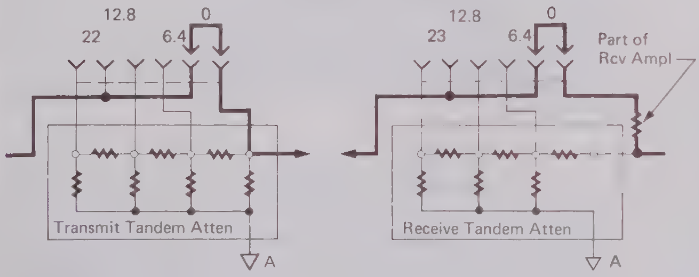
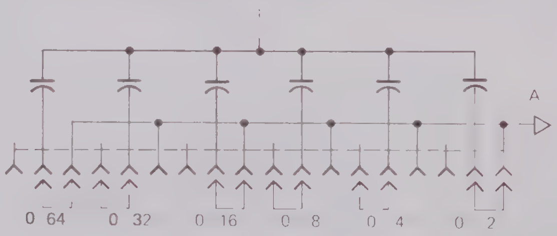

12.8
0
22
6.4
Transmit Tandem Atten
A
12.8
0
23
6.4
Part of Rcv Ampl
Receive Tandem Atten
A

Figure D. NBO Capacitors Strapped for 0.082 μF


A
0 64
0 32
0 16
0 8
0 4
0 2

Notes:

1. Tandem Attenuators. The tandem attenuators on model 1 of some channel units have three strappable values: 0, 13, and 22 dB (transmit) or 0, 10, and 23 dB (receive).

Figure 3-8. Four-Wire VF Drop Levels

	Application and (Tandem Attenuator Setting, dB)	Level Range, dBm
Four-Wire Transmit	Nontandem (0)	—17.5 to —11.2
	Special (6.4)	—11.1 to —4.8
	Special (12.8)	—4.7 to +1.6
	Tandem (22)	+4.5 to +10.8
	*Special (13)	—4.5 to +1.8
Four-Wire Receive	Nontandem (0)	+8.5 to +2.2
	Special (6.4)	+2.1 to —4.2
	Special (12.8)	—4.3 to —10.6
	Tandem (23)	—14.5 to —20.8
	*Special (10)	—1.5 to —7.8

*On model 1 of some channel units, the tandem attenuators have a 13-dB section (transmit) and a 10-dB section (receive) instead of the present 6.4-dB and 12.8-dB sections.

segmented curve approximates a continuous compression law (μ-law) curve defined as:

$$y = \frac{\ln(1 \pm \mu x)}{\ln(1 + \mu)}$$

where x and y respectively are the coder input and output and $\mu = 255$.

3.35 The curve has eight positive segments and eight negative segments with 16 steps in each segment, a total of 256 quantizing steps. Within each segment, the steps are uniform; in adjacent segments, according to the compression law, step sizes are in a 2/1 ratio with the smallest steps at the lowest signal levels.

3.36 In the coder, the sample voltage is compared with a reference voltage adjusted under logic control by the successive approximation method. In this method, the reference voltage is set at the halfway point on the portion of the curve where, based on results of preceding comparisons, the sample voltage is known to lie.

3.37 In the first comparison, the polarity of the sample is determined and encoded as bit 1 of the eight-bit pcm word; positive is logic 1 and negative is logic 0. Succeeding comparisons localize the sample voltage to one segment of the curve and encode the segment number as bits 2, 3, and 4. Then, the applicable step in that segment is found and the step number encoded as bits 5, 6, 7, and 8. The lowest-numbered bit is the most significant bit.

3.38 Transmit Timing. In modes 1, 2, and 3, the transmit unit supplies a single clock signal (ClkT′) and 24 channel pulse signals, ChPT-1′ through ChPT-24′. Both digroups use the same transmit timing signals. The transmit clock sets the bit rate and provides framing bit time slots, the channel pulse identifies the channel time slot, and the relative width of the channel pulse distinguishes between nonsignaling and signaling frames. Figure 3-11A is the transmit timing diagram.

3.39 The transmit clock has 192 active cycles per frame (8 bits × 24 channels = 192). Multiplying 192 by the 8-kHz frame rate gives 1.536 MHz. In mode 1, the transmit clock is blanked five cycles in each frame for framing bit insertion; the required clock frequency is therefore 1.536 MHz + 5 × 8 kHz = 1.576 MHz. In modes 2 and 3, the clock is blanked one cycle per frame and the required clock frequency is 1.536 MHz + 1 × 8 kHz = 1.544 MHz.

NOTE: The general channel pulse designation is ChPT-(n)′ or ChPR-(n)′ where n is the channel number. Channel $n-1$ and channel $n+1$, respectively, refer to the channel that precedes and follows in the 1 through 24 sampling sequence.

3.40 The falling edge of channel pulse ChPT-(n)′ occurs at bit 8 of channel $n-1$. The next active clock cycle defines the bit 1 time slot of channel n. The rising edge of the channel pulse occurs at bit 1 in nonsignaling frames or one clock cycle later at bit 2 in signaling frames.

3.41 In the transmit unit, framing bits are inserted in time slots preceding bit 1 of certain channels. The transmit clock is blanked one cycle at each framing bit time slot, stretching the channel pulses. Listed below are the widths of channel pulses in nonsignaling and signaling frames, respectively.

(a) Channel 2, mode 1: 3 and 4 cycles
(b) Channel 2, mode 2 or 3: 2 and 3 cycles
(c) Channels 8, 14, and 20, mode 1: 2 and 3 cycles
(d) All other channels: 1 and 2 cycles

NOTE: Because of delay in the transmit unit's zero code detector, the channel n pcm word is transmitted to the line while channel unit $n+1$ is applying its pcm word to the PCMT bus. This is the reason that the clock is blanked during ChPT-2′, for example, to create time slots for framing bits preceding channel 1.

3.42 The vf transmit signals are sampled at the beginning of each channel time slot and the encoded eight-bit word that represents the sample voltage is output on Dx one frame (125 μs) later. Although the coder has a three-state output, an additional three-state buffer is used to enhance system noise performance. Until enabled by TSx′, the buffer presents a high impedance to the PCMT bus.

3.43 Receive Timing. In mode 1, the receive unit supplies the same clock signal (ClkR′) and 24 channel pulse signals to both digroups. In modes 2 and 3, the receive unit supplies separate clocks and channel pulses to digroup A and digroup B. Transmit clock frequencies and channel pulse widths described previously are also applicable to the receive counterparts. Because the channel word is not delayed in the receive unit as it is in the transmit unit, ClkR′ is blanked during ChPR-1′, for example, whereas ClkT′ is blanked during ChPT-2′. Figure 3-11B is the receive timing diagram.

3.44 During a channel unit's assigned time slot, the decoder accepts the eight-bit word from the PCMR′ bus. The analog voltage decoded from the eight bits (or seven bits in a signaling frame) is held on the VFr output until the next frame 125 μs later. In signaling frame 6 or 12, the signaling/supervisory status derived from bit 8 is held on the Sig-r output until the next signaling frame 750 μs later.

3.45 Trunk Make Busy. Three signals (TMB1′, TMB2′, and TP′) involved in trunk processing during a system alarm condition are bused from the 91420 Alarm Control Unit to all channel units of the associated digroup(s).

3.46 Signaling. The details of signaling and supervisory circuits are illustrated and described in the GTE Practices listed in figure 1-2 for individual channel unit types. Timing signal SigEnBT from the transmit unit is distributed to all channel units; SigEnBR-A′ and SigEnBR-B′ from the receive unit are distributed to the channel units of digroups A and B, respectively. These signals, which change state at the beginning of frames 6 and 12, are required by channel units that multiplex two signaling channels on bit 8 of the pcm word,

Figure 3-9. Comparison of Four-Wire VF Levels in the 9002B and 9004A Channel Banks

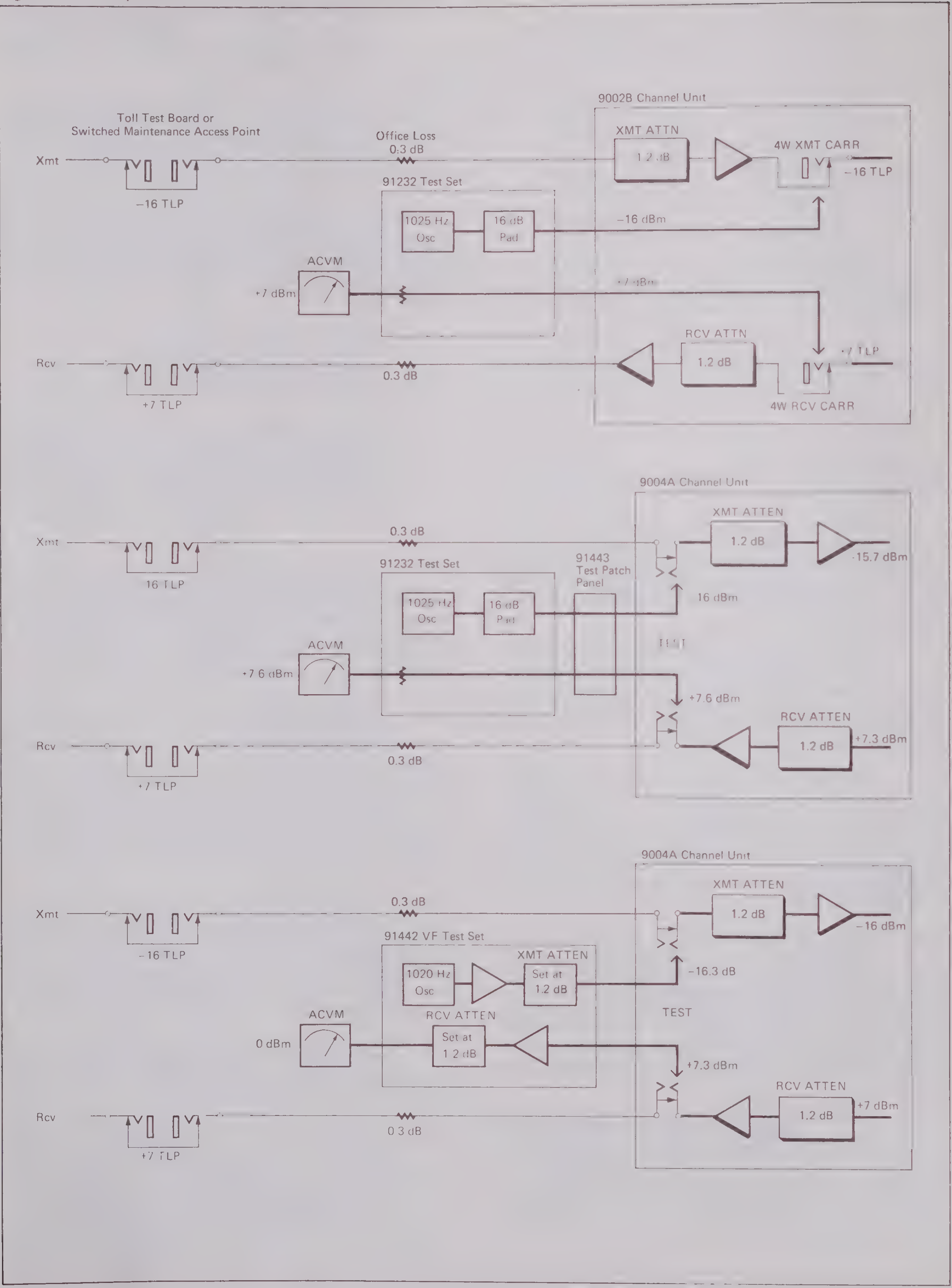
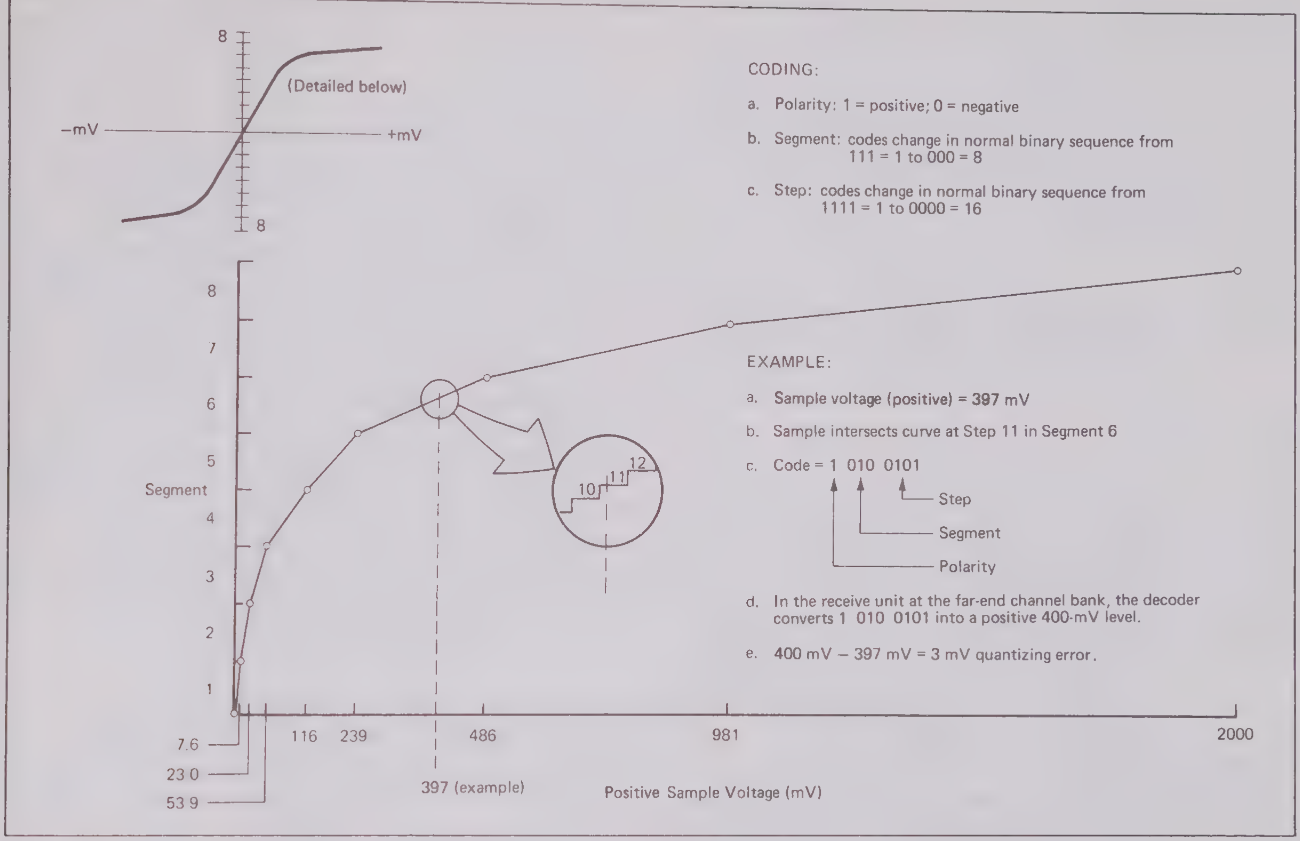

9002B Channel Unit
Toll Test Board or
Switched Maintenance Access Point
Xmt
Office Loss
0.3 dB
XMT ATTN
1.2 dB
4W XMT CARR
−16 TLP
−16 TLP
91232 Test Set
1025 Hz
Osc
16 dB
Pad
−16 dBm
ACVM
+7 dBm
+7 dBm
RCV ATTN
Rcv
1.2 dB
+7 TLP
0.3 dB
+7 TLP
4W RCV CARR
9004A Channel Unit
XMT ATTEN
Xmt
0.3 dB
1.2 dB
−15.7 dBm
16 TLP
91232 Test Set
91443
Test Patch
Panel
1025 Hz
Osc
16 dB
Pad
16 dBm
TEST
ACVM
+7.6 dBm
+7.6 dBm
RCV ATTEN
Rcv
1.2 dB
+7.3 dBm
0.3 dB
+7 TLP
9004A Channel Unit
XMT ATTEN
Xmt
0.3 dB
1.2 dB
−16 dBm
−16 TLP
91442 VF Test Set
XMT ATTEN
1020 Hz
Osc
Set at
1.2 dB
−16.3 dB
ACVM
RCV ATTEN
TEST
0 dBm
Set at
1.2 dB
+7.3 dBm
RCV ATTEN
Rcv
1.2 dB
+7 dBm
0.3 dB
+7 TLP

Figure 3-10. Quantization of Sample Voltages in Channel Unit Codec



CODING:

a. Polarity: 1 = positive; 0 = negative

b. Segment: codes change in normal binary sequence from 111 = 1 to 000 = 8

c. Step: codes change in normal binary sequence from 1111 = 1 to 0000 = 16

EXAMPLE:

a. Sample voltage (positive) = 397 mV

b. Sample intersects curve at Step 11 in Segment 6

c. Code = 1 010 0101

d. In the receive unit at the far-end channel bank, the decoder converts 1 010 0101 into a positive 400-mV level.

e. 400 mV − 397 mV = 3 mV quantizing error.

channel A in frame 6 and channel B in frame 12. In frames 6 through 11, SigEnBT is logic 0 and SigEnBR′ is logic 1.

3.47 TEST Connector. The vf drop circuits (and E&M leads) are accessible through the 12-pin TEST receptacle connector on the front of the channel unit with a 796A Patch Cord. Patching from TEST on a failed channel unit to TEST on a matching spare channel unit at each end will restore service. The 796A Patch Cord is wired so that the drop of the failed channel is connected to the carrier of the spare channel. Also, the spare drop is connected to the failed carrier.

3.48 For measuring transmission levels and other channel parameters, the TEST connector is patched to a 91442 VF Test Set or a 91443 Test Patch Panel. There, the vf and signaling circuits of the channel can be accessed in both directions, toward the carrier and toward the drop, with conventional test equipment and cords.

91421 Mode 1 Transmit Unit

3.49 PCM Signal Flow. Eight-bit channel words from the pcm buses of digroups A and B are clocked into the zero code detectors shown at the left side of figure 3-12. The first eight clock pulses load an input register in the zero code detector. Then, a Load pulse transfers the bits in parallel to an output register, from where they exit serially on the next eight clock pulses. If the input register is loaded with all 0's, bit 7 is forced to 1 when the word goes into the output register. Similarly, when AC4 is high, bit 2 of each channel word is forced to 0 as an alarm indication to the far terminal.

3.50 The 1.576-MHz transmit clock (ClkT or ClkT′) has gaps in the time slots assigned to framing bits. During these gaps, the S, F1, and FO bits (figure 2-4B) are inserted in the transmit pcm signal.

3.51 In the digroup combiner, the bit streams of digroups A and B are interleaved so that a bit from digroup A is followed immediately by the corresponding data bit or framing bit from digroup B. See figure 2-4C.

3.52 Digital transmission equipment operates most efficiently when the digital signal has an even distribution of 1's and 0's. The function of the scrambler is to break up long strings of 1's that may appear in a pcm signal, particularly when traffic is light. The scrambler output is the exclusive-OR of the present input bit and the preceding output bit. Thus, a 11111111 input becomes a 10101010 output.

3.53 The bipolar converter samples the scrambler output and routes alternate 1's to the two halves of the center-tapped transformer so that consecutive pulses have opposite polarity. Pulses are generated during the last half of the 3.152-MHz clock cycles.

3.54 When the channel bank is in looped terminal (LT) status, AC5′ from the alarm control unit goes low, activating the 1's generator and operating relay K1 to send an all-1's signal to the line.

3.55 Note that the AC5′ input is connected directly to the winked AC5′ (WAC5′) output. The wink feature used in mode 2 is not required in mode 1.

3.56 Transmit Clock. Channel bank transmit timing is controlled by a 3.152-MHz clock signal from one of three sources: an internal clock, looped receive clock (Rcv Clk A) from the mode 1 receive unit, or Ext Clk from an external source. Clock selection is made by the E/F and G/H strapping plugs. During a local alarm, looped terminal (LT) status, or looped line (LL) status, AC7-A from the alarm control unit is high. If the unit is strapped for the looped receive clock option, AC7-A causes a switch from Rcv Clk A to internal clock.

Figure 3-11. Channel Unit Timing Diagram

Figure A. Transmit Timing Diagram

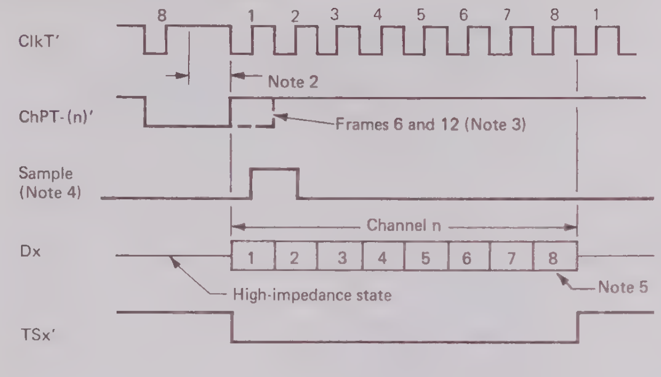
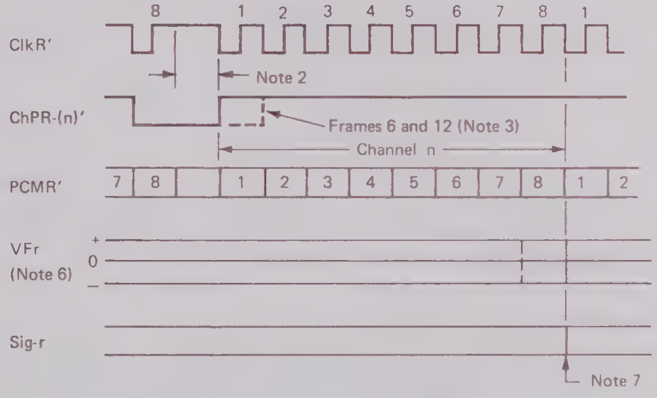


Figure B. Receive Timing Diagram



Notes:

1. Synchronization. In end-to-end operation, transmit clock ClkT′ and receive clock ClkR′ may be synchronous or asynchronous according to system application.
2. Framing Bits. The transmit clock and receive clock have gaps at the framing bit time slots. That is, the level remains high for one or two cycles. In mode 1, there are three one-cycle gaps and one two-cycle gap in each frame. In modes 2 and 3, there is one one-cycle gap in each frame.
3. Channel Pulse. In nonsignaling frames, the channel pulse width is one clock cycle plus the gaps referred to in Note 2, where applicable. In signaling frames 6 and 12, the channel pulse width is extended one additional clock cycle.
4. Sample Pulse. The analog voltage on VFx is sampled in one frame and the encoded value is output on Dx as a seven- or eight-bit pcm word in the next frame 125 µs later.
5. Transmit Signaling. In frames 6 and 12, the signaling state is gated directly through the coder as bit 8 of the pcm word; that is, logic 1 on Sig-x produces logic 1 on Dx.
6. VF Receive. The analog voltage is decoded from bits 1-8 of the pcm word in nonsignaling frames and bits 1-7 in signaling frames. The voltage is applied to VFr after bit 8 and held for one frame (125 µs).
7. Receive Signaling. In signaling frames 6 and 12, the logic level of bit 8 in the pcm word is latched in the decoder and held on Sig-r until updated in the next signaling frame.

3.57 A flip-flop divides the transmit clock frequency by two and supplies opposite-phase 1.576-MHz signals (A Enbl and B Enbl) that interleave the A and B pcm signals in the digroup combiner.

3.58 Word Bit Counter. Driven by ClkT (1.576 MHz with gaps), the word bit counter generates a 40-nanosecond Load pulse at the beginning of bit 1 time slot, a D7′ pulse that goes low at the center of bit 7 time slot, and a D8 pulse that goes high at the center of bit 8 time slot. D7′ is one clock period wide; D8 is one-half clock period wide.

3.59 Channel Pulse Generator. The channel pulse generator consists of a mod-24 counter clocked by D7′ and a 1-of-24 decoder. The decoder output signals, channel pulses ChPT-1′ through ChPT-24′, are distributed to the 24 channel units of each digroup where they function as codec transmit sync pulses. Controlled by an Enbl signal from the frame sync circuit, the channel pulse goes low at the beginning of the D8 pulse of the preceding channel and returns high one clock cycle later in nonsignaling frames or two clock cycles later in signaling frames 6 and 12. See figure 3-11A.

3.60 Channel pulse ChPT-2′ remains low for two additional clock cycles and ChPT-8′, -14′, and -20′ remain low for one additional clock cycle. This allows for the insertion of S and F framing bits in front of the channel 1 word and an F framing bit in front of the channel 7, 13, and 19 words. The eight-bit delay in the zero code detector is the reason channel pulse 2, for example, is "stretched" because of framing bit insertion ahead of channel 1.

3.61 Framing Bit Timing. The D8 pulse and the channel pulses for channels 1, 7, 13, and 19 create four Enbl signals to control the insertion of S and F framing bits into the digroup pcm signals. Also, a 1.576-MHz clock with gaps at the framing bit time slots is generated; this clock is designated ClkT.

3.62 F-Bit Generator. The F-bit signal is the output of a flip-flop set by channel pulse 1 or 7 and reset by channel pulse 13 or 19. The 1100 F-bit pattern in the time slots preceding channel words 1, 7, 13, and 19 results when the F-bit signal is gated by the Enbl signals described in the preceding paragraph. This gating takes place in the framing bit insertion block of figure 3-12.

NOTE: F-bits are not presently used for terminal or signaling framing. The A/B strapping plug allows for the option of a 1100 pattern from the F-bit generator or a different pattern from an external source.

3.63 S-Bit Generator. Channel pulse ChPT-1′ drives a mod-12 counter with four binary outputs. These outputs are decoded by the S-bit generator to form and interleave the two S-bit patterns: 101010 in odd-numbered frames 1 through 11 and 001110 in even-numbered frames 2 through 12.

3.64 Frame Sync. The frame sync circuit generates the Enbl signal to the channel pulse generator as described previously. Signaling frames 6 and 12, during which the Enbl signal must be one clock cycle wider than in nonsignaling frames, are identified by decoding the outputs of the mod-12 counter. If signaling is not required, the C/D strapping plug inserted in position D inhibits the extra clock cycle in frames 6 and 12.

3.65 Another output of the frame sync circuit, SigEnBT, switches from high to low at the beginning of frame 6 and back to high at the beginning of frame 12. This signal is distributed to the channel units of both A and B digroups.

91422 Mode 2 and 91423 Mode 3 Transmit Units

3.66 PCM Input Signals. Eight-bit channel words from the pcm buses of digroups A and B are clocked into the zero code detectors shown at the left side of figures 3-13 and 3-14. The first eight clock pulses load an input register. Then, a Load pulse transfers the bits in parallel to an output register, from where they exit serially on the next eight clock pulses. If the input register is loaded with all 0's, bit 7 is forced to 1 when the word goes into the output register. Similarly, when AC4 is high, bit 2 of each channel word is forced to 0 as an alarm indication to the far terminal.

3.67 The 1.544-MHz transmit clock (ClkT or ClkT′) has gaps in the time slots assigned to the S framing bits. During these gaps, the S-bits (figure 2-4A) are inserted in the transmit pcm signal.

3.68 Unipolar Output Signals, Mode 2 (figure 3-13). When the channel bank is in looped terminal (LT) status, AC5′ from the applicable alarm control unit goes low, switching the unipolar transmit signal, Xmt A or Xmt B, to the receive unit via Loop A or Loop B.

3.69 With the channel bank in LT status, depressing the TEST pushbutton on the syndes unit generates a 300-ms logic 0 pulse on LP′. By inhibiting gate 1 and gate 2, the pulse unloops the transmit signal and produces a winked AC5′ signal (WAC5-A′ or -B′) to the receive unit.

3.70 DS1 Bipolar Output Signals, Mode 3 (figure 3-14). The bipolar converter routes alternate 1's in the transmit bit stream to the two halves of the center-tapped transformer so that consecutive output pulses have opposite polarity. Pulses are generated during the last half of the 1.544-MHz clock cycles.

3.71 When the channel bank is in looped terminal (LT) status, AC5′ from the applicable alarm control unit goes low, activating the 1's generator and operating relay K1 or K2 to send an all-1's signal to the line.

3.72 Note that the AC5′ inputs are connected directly to the winked AC5′ (WAC5′) outputs. The wink feature used in mode 2 is not required in mode 3.

3.73 Transmit Clock. Channel bank transmit timing is controlled by a 1.544-MHz clock signal from one of four sources: an internal oscillator, looped receive clock (Rcv Clk A or B) or Ext Clk from an external source. Clock selection is made by the E/F and G/H strapping plugs. In mode 2, Rcv Clk A and B are from the syndes unit; in mode 3, they are from the receive unit.

3.74 If the transmit unit is strapped for the looped receive clock option, Rcv Clk A is the clock source in normal operation. During a local alarm, looped terminal (LT) status, or looped line (LL) status, AC7 from the alarm control unit of the applicable digroup goes high. If the condition affects only digroup A, Rcv Clk B is switched in as the transmit clock source. If it affects both digroups, internal clock is selected.

3.75 Word Bit Counter. Driven by ClkT (1.544 MHz with gaps), the word bit counter generates a 40-nanosecond Load pulse at the beginning of bit 1 time slot, a D7′ pulse that goes low at the center of bit 7 time slot, and a D8 pulse that goes high at the center of bit 8 time slot. D7′ is one clock period wide; D8 is one-half clock period wide.

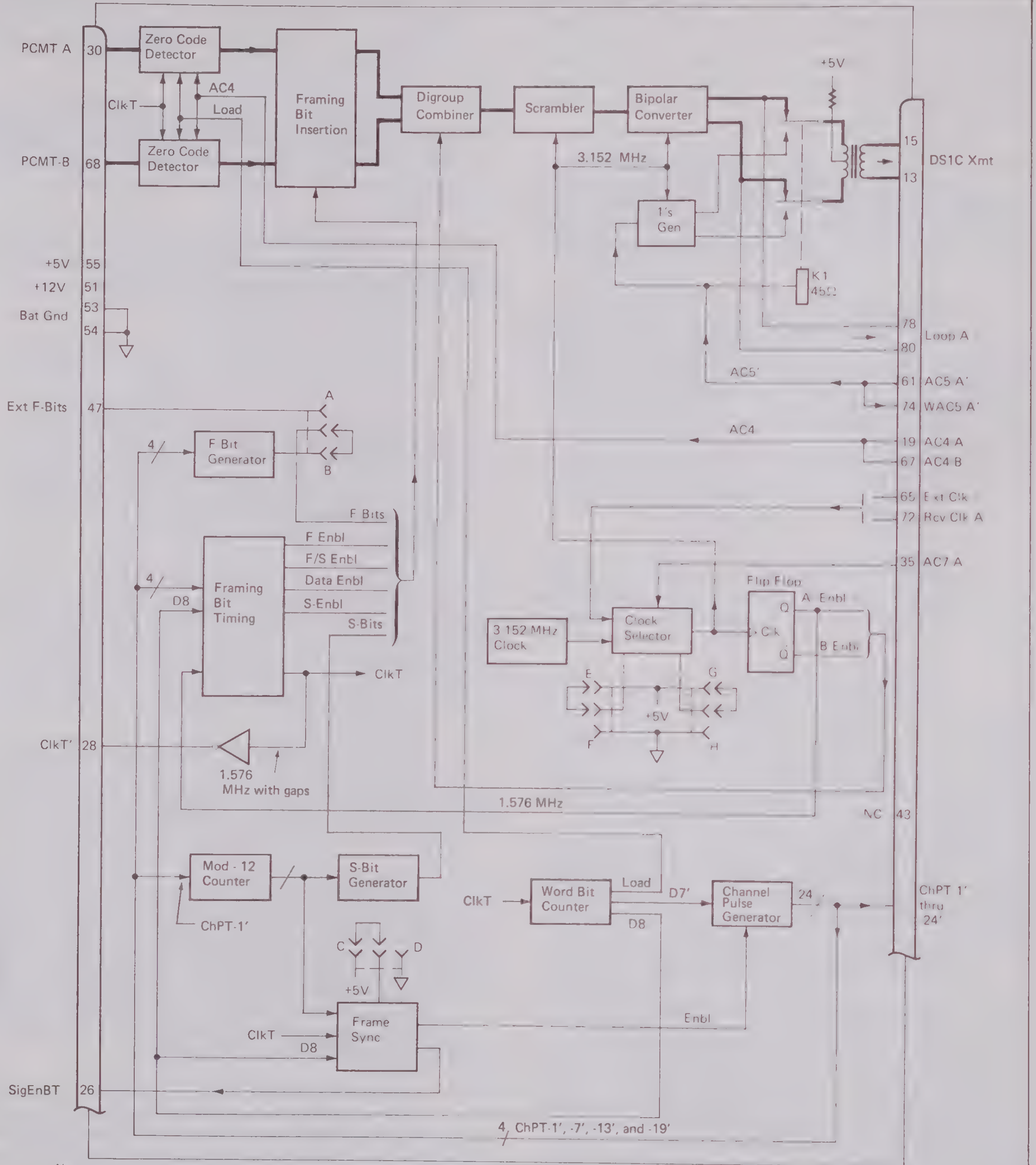
3.76 Channel Pulse Generator. The channel pulse generator consists of a mod-24 counter clocked by D7′ and a 1-of-24 decoder. The decoder output signals, channel pulses ChPT-1′ through ChPT-24′, are distributed to the 24 channel units of each digroup where they function as codec transmit sync pulses. Controlled by an Enbl signal from the frame sync circuit, the channel pulse goes low at the beginning of the D8 pulse of the preceding channel and returns high one clock cycle later in nonsignaling frames or two cycles later in signaling frames 6 and 12. See figure 3-11A.

3.77 Channel pulse ChPT-2′ remains low for one additional clock cycle to allow for insertion of the S framing bit in front of the channel 1 word. The eight-bit delay in the zero code detector is the reason that channel pulse 2 is "stretched" because of framing bit insertion ahead of channel 1.

3.78 Framing Bit Timing. The D8 pulse and channel pulse ChPT-1′ create two Enbl signals to control the insertion of S framing bits into the digroup pcm signals. Also, a 1.544-MHz clock with one-cycle gaps at the framing bit time slots is generated; this clock is designated ClkT.

3.79 S-Bit Generator. Channel pulse ChPT-1′ drives a mod-12 counter with four binary outputs. These outputs are decoded by the S-bit generator to form and interleave the two S-bit patterns: 101010 in odd-numbered frames 1 through 11 and 001110 in even-numbered frames 2 through 12.

Figure 3-12. 91421 Mode 1 Transmit Unit, Circuit Diagram


PCMT A
30
Zero Code Detector
ClkT
AC4
Load
PCMT-B
68
Zero Code Detector
Framing Bit Insertion
Digroup Combiner
Scrambler
Bipolar Converter
+5V
3.152 MHz
1's Gen
K1 450
15
13
DS1C Xmt
+5V
55
+12V
51
53
Bat Gnd
54
78
Loop A
80
AC5'
61
AC5 A'
74
WAC5 A'
Ext F-Bits
47
A
B
4
F Bit Generator
AC4
19
AC4 A
67
AC4 B
65
Ext Clk
72
Rcv Clk A
F Bits
F Enbl
F/S Enbl
Data Enbl
S-Enbl
S-Bits
4
D8
Framing Bit Timing
35
AC7 A
Flip Flop
A Enbl
Q
Clk
B Enbl
3 152 MHz Clock
Clock Selector
ClkT
E
G
+5V
F
H
ClkT'
28
1.576 MHz with gaps
1.576 MHz
NC
43
Mod - 12 Counter
S-Bit Generator
ChPT-1'
ClkT
Word Bit Counter
Load
D7'
D8
Channel Pulse Generator
24
ChPT 1' thru 24'
C
D
+5V
ClkT
D8
Frame Sync
Enbl
SigEnBT
26
4
ChPT-1', -7', -13', and -19'

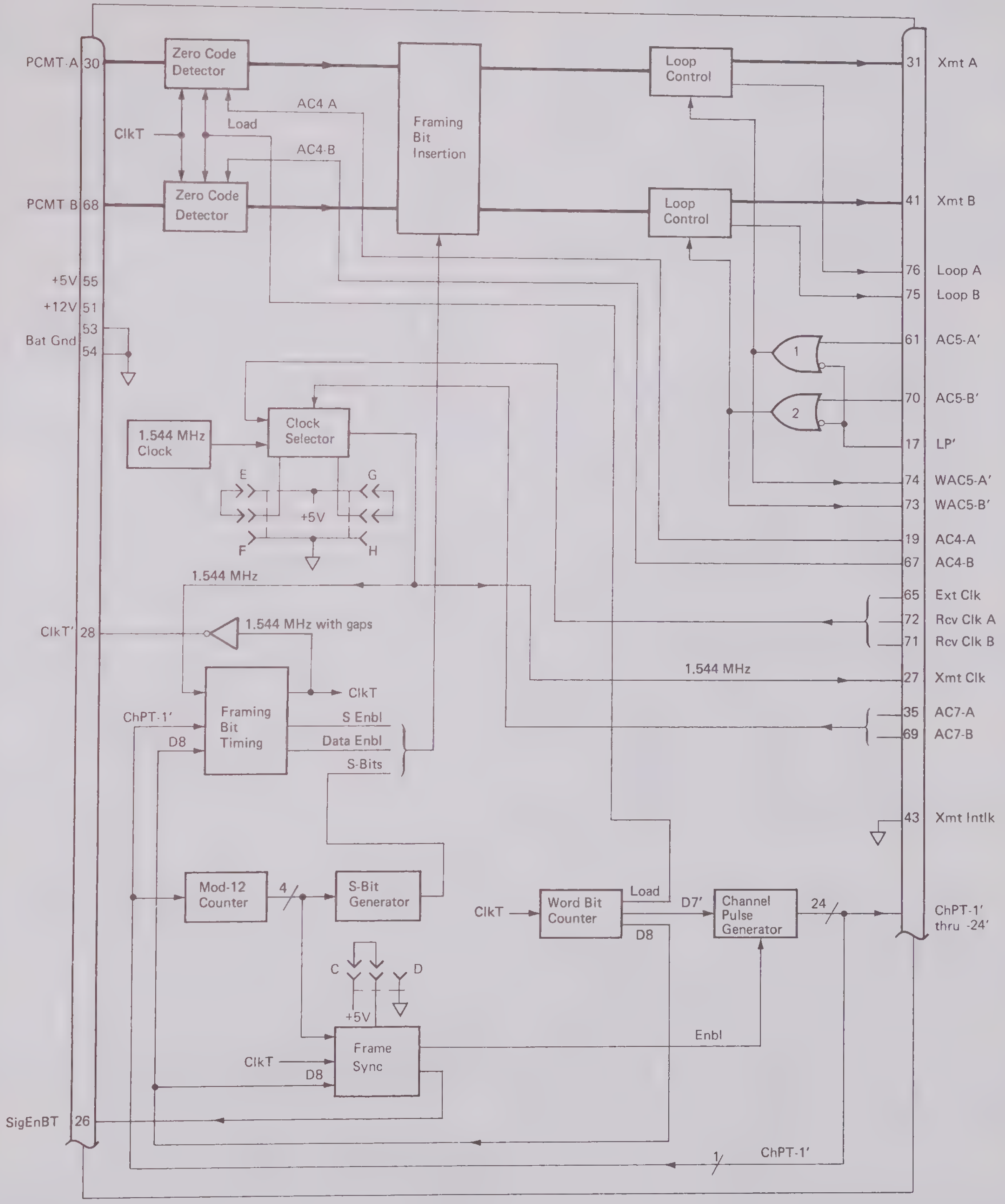
Notes:

1. Strapping Options

Option		Strapping Plug Positions
F-bit source	External Internal	A B*
Channel signaling via bit 8	Yes No	C* D
Transmit clock source	Internal Looped receive clock External	E,G* F, G E, H

*Factory strapping.

Figure 3-13. 91422 Mode 2 Transmit Unit, Circuit Diagram


PCMT A 30
PCMT B 68
+5V 55
+12V 51
53
Bat Gnd
54
ClkT' 28
ChPT-1'
D8
SigEnBT 26
Zero Code Detector
Zero Code Detector
ClkT
Load
AC4 A
AC4-B
Framing Bit Insertion
Loop Control
Loop Control
1.544 MHz Clock
Clock Selector
E
G
F
H
+5V
1.544 MHz
1.544 MHz with gaps
Framing Bit Timing
ClkT
S Enbl
Data Enbl
S-Bits
Mod-12 Counter
4
S-Bit Generator
C
D
+5V
ClkT
D8
Frame Sync
ClkT
Word Bit Counter
Load
D7'
D8
Channel Pulse Generator
24
Enbl
1
ChPT-1'
1
2
1.544 MHz
31 Xmt A
41 Xmt B
76 Loop A
75 Loop B
61 AC5-A'
70 AC5-B'
17 LP'
74 WAC5-A'
73 WAC5-B'
19 AC4-A
67 AC4-B
65 Ext Clk
72 Rcv Clk A
71 Rcv Clk B
27 Xmt Clk
35 AC7-A
69 AC7-B
43 Xmt Intlk
ChPT-1' thru -24'

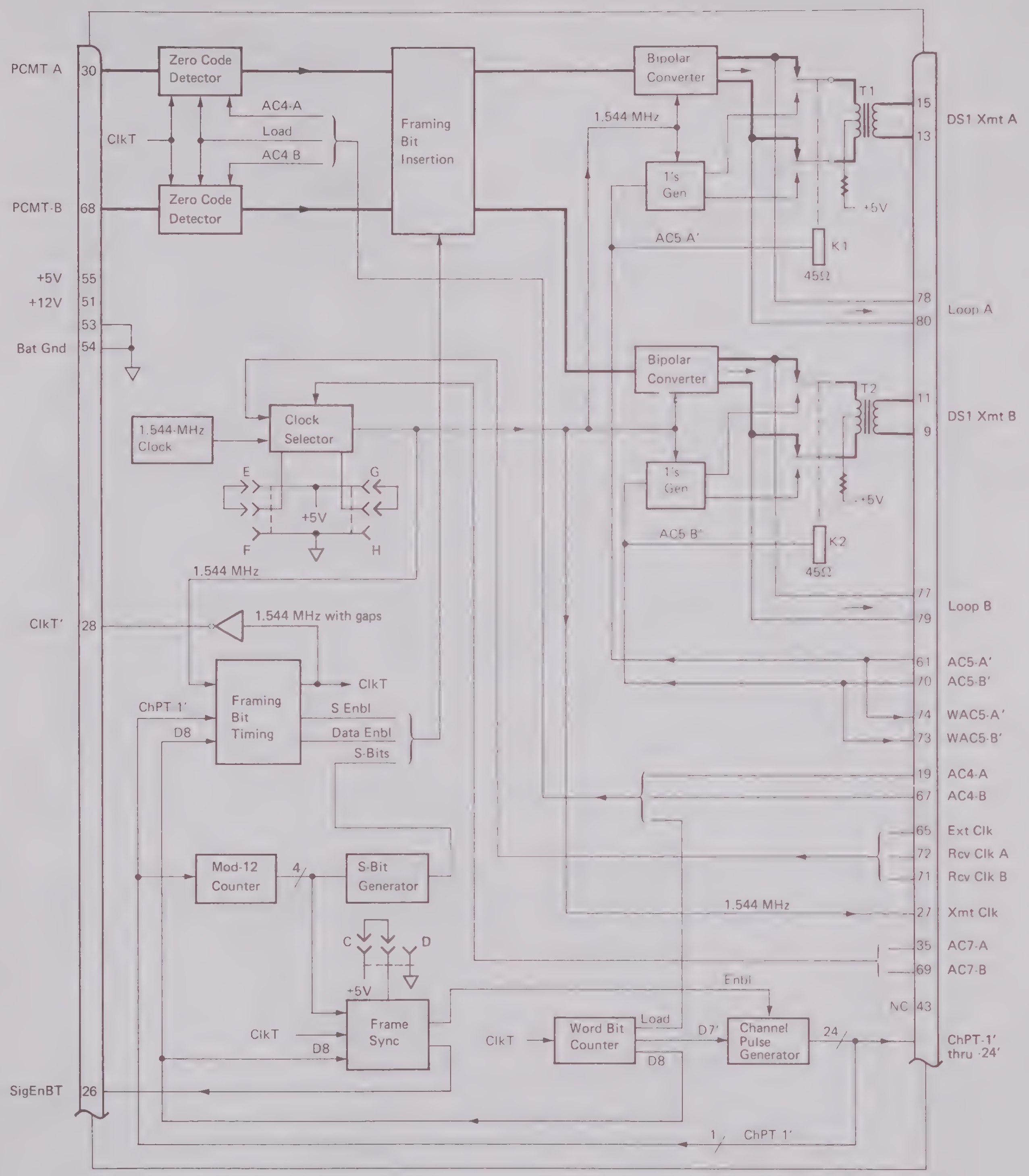
Notes:

1. Strapping Options

Option		Strapping Plug Positions	
Channel signaling via bit 8	Yes	C	*
	No	D	
Transmit clock source	Internal	E, G	*
	Looped receive clock	F, G	
	External	E, H	

*Factory strapping

Figure 3-14. 91423 Mode 3 Transmit Unit, Circuit Diagram


PCMT A
30
Zero Code Detector
AC4-A
ClkT
Load
AC4 B
Zero Code Detector
PCMT-B
68
Framing Bit Insertion
Bipolar Converter
1.544 MHz
1's Gen
T1
15
13
DS1 Xmt A
+5V
AC5 A'
K1
45Ω
78
80
Loop A
+5V
+12V
Bat Gnd
55
51
53
54
Bipolar Converter
T2
11
9
DS1 Xmt B
1.544-MHz Clock
Clock Selector
E
G
+5V
F
H
1's Gen
+5V
AC5 B'
K2
45Ω
77
79
Loop B
1.544 MHz
ClkT'
28
1.544 MHz with gaps
ClkT
ChPT 1'
D8
Framing Bit Timing
S Enbl
Data Enbl
S-Bits
61
70
74
73
AC5-A'
AC5-B'
WAC5-A'
WAC5-B'
19
67
AC4-A
AC4-B
65
72
71
Ext Clk
Rcv Clk A
Rcv Clk B
Mod-12 Counter
4
S-Bit Generator
1.544 MHz
27
Xmt Clk
C
D
35
69
AC7-A
AC7-B
+5V
Enbl
NC
43
ClkT
Frame Sync
D8
ClkT
Word Bit Counter
Load
D7'
D8
Channel Pulse Generator
24
ChPT-1' thru -24'
SigEnBT
26
1
ChPT 1'

Notes:

1. Strapping Options

Option		Strapping Plug Positions
Channel signaling via bit 8	Yes	C *
	No	D
Transmit clock source	Internal	E, G *
	Looped receive clock	F, G
	External	E, H

*Factory strapping.

3.80 Frame Sync. The frame sync circuit generates the Enbl signal to the channel pulse generator as described previously. Signaling frames 6 and 12, during which the Enbl signal must be one clock cycle wider than in nonsignaling frames, are identified by decoding the outputs of the mod-12 counter. If signaling is not required, the C/D strapping plug inserted in position D inhibits the extra clock cycle in frames 6 and 12.

3.81 Another output of the frame sync circuit, SigEnBT, switches from high to low at the beginning of frame 6 and back to high at the beginning of frame 12. This signal is distributed to the channel units of both A and B digroups.

91431 Mode 1 Receive Unit

3.82 The main pcm signal flow and the clock circuits of the mode 1 receive unit are shown on sheet 1 of figure 3-15. Most of the timing and control circuits, which are described beginning in paragraph 3.108, appear on sheet 2.

NOTE: Designations of leads at the right side of figure 3-15 have a suffix letter "A" because the wiring on the shelf is associated with digroup A in the mode 2 and mode 3 applications.

3.83 PCM Signal Flow. From P1-13 and -11 at the right side of figure 3-15, sheet 1, the bipolar 3.152-Mb/s DS1C receive signal goes through a 12-dB pad and a transformer that provide isolation and a balanced receive line termination. When the channel bank is looped, control line WAC5-A′ goes low, operating relay K1 and switching the input circuit to the looped DS1C signal from the 91421 Mode 1 Transmit Unit at P1-4 and -2. The two 511-ohm resistors are pullups for the open-collector gates on the transmit unit.

3.84 In the input circuit, the receive pcm signal is converted to unipolar format and a clock that is phase-locked to the pcm signal frequency is generated. In the absence of a receive pcm signal, the clock oscillator free-runs at 3.152 MHz nominal.

3.85 The descrambler restores the pcm signal to the same sequence of 1's and 0's it had at the input to the scrambler in the transmit unit. The descrambler output is the exclusive-OR of the present input bit and the preceding output bit. Thus, 10101010 becomes 11111111. The format of the output signal is nonreturn to zero (nrz).

3.86 In the demultiplexer, under control of the 1.576-MHz A and B clocks, alternate bits are routed to the A and B pcm signal buses. The phase comparator looks at both signals during the S-bit time slot (D9 digit pulse) and produces feedback to the clock generator to align the A and B clocks with the A and B time slots in the 3.152-Mb/s DS1C signal.

3.87 Normally, the two pcm signals from the demultiplexer pass through the output signal selector to their respective digroup channel units via the PCMR-A′ and PCMR-B′ buses. Activation of one of the four control lines to the selector alters the vf and/or signaling bits or inserts a digital tone as described in paragraph 3.109. Control lines AC3-A and AC6-A′ from the 91420 Alarm Control Unit are activated by a remote alarm and a system alarm, respectively. Fr Sch is active when frame sync is lost. Tn Enbl′ is active when the channel bank is looped and the ON/OFF switch is set to ON.

3.88 Clocks. From pin 10 of P1, the 3.152-MHz recovered clock is fed over the Rcv Clk A line to the 91421 Mode 1 Transmit Unit where it is available for the looped receive clock option.

3.89 In the clock generator, the 3.152-MHz clock drives a D-type flip-flop that produces complementary 1.576-MHz A and B clocks. Because the digroups are synchronous, only one 1.576-MHz clock is needed for generating the timing signals that synchronize the receive unit timing signals and the channel unit decoders with the incoming pcm signal. The B clock is chosen for this purpose and is designated R-Clk′.

3.90 The clock designated ClkR′ is derived by inhibiting the 1.576-MHz clock at the S-bit time slot and the four F-bit time slots in each frame with the D9 and DF timing pulses, respectively. Actually, this clock will have 1,536,000 active cycles/second, which provides 8 time slots for 24 channels at the 8-kHz sampling rate (8 × 24 × 8000 = 1,536,000).

91432 Mode 2 Receive Unit

3.91 The 91432 unit (figure 3-16) has input ports for digroup A and B pcm signals from the 91426 Syndes Unit. These asynchronous 1.544-Mb/s unipolar signals are processed independently. Sheet 1 of figure 3-16 shows the inputs and ouputs to the identical digroup A and B receive circuits, which are detailed on sheet 2. Also on sheet 1 is the digital tone generator that serves both digroups.

3.92 The main pcm signals and clocks in the digroup receive circuit and the digital tone generator are described below. The description of timing and control circuits begins at paragraph 3.108.

3.93 PCM Signal Flow. The unipolar pcm signal (Rcv) and the 1.544-MHz clock (Rcv Clk) from the syndes unit enter at the right side of figure 3-16, sheet 2. If the digroup is looped, WAC5′ (winked AC5′) goes low and the two selectors switch to the pcm signal (Loop) and clock (Xmt Clk) from the 91422 Mode 2 Transmit Unit.

3.94 The pcm signal passes through gate 1 (paragraph 3.119) to the retiming circuit. Normally, the retimed signal goes through the output signal selector to the applicable digroup channel units via the PCMR′ bus. The format is nonreturn-to-zero (nrz).

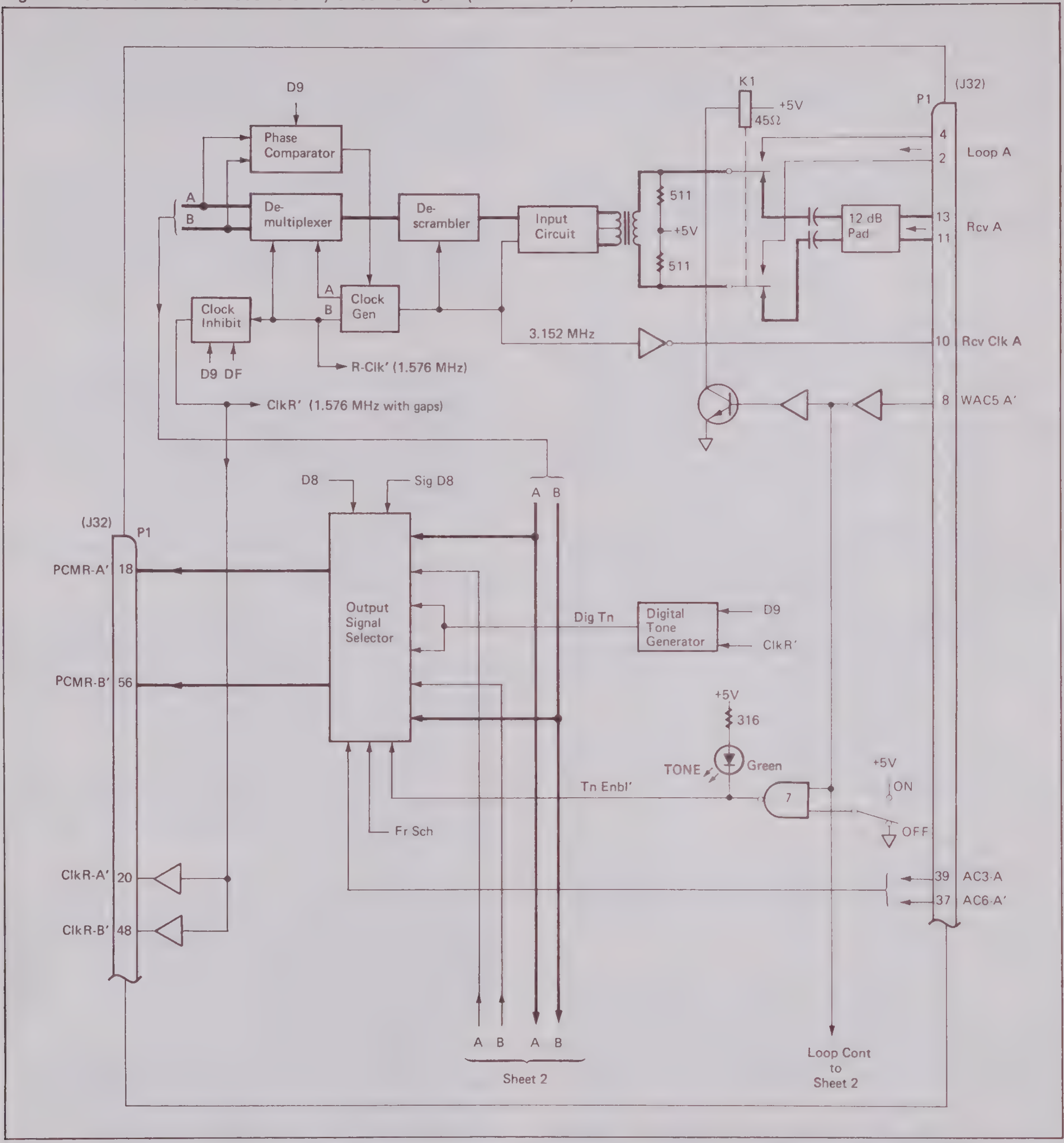
3.95 Activation of one of the four control lines to the selector alters the vf and/or signaling bits or inserts a digital tone as described in paragraph 3.109. Control lines AC3 and AC6′ from the 91420 Alarm Control Unit are activated by a remote alarm and system alarm, respectively. Fr Sch becomes active when frame sync is lost. Tn Enbl′ is active while the digroup is looped if the ON/OFF switch is set to ON.

3.96 Clocks. The 91426 Syndes Unit supplies a 1.544-MHz clock (Rcv Clk A or B) to each digroup receive circuit; these clocks may be asynchronous. The 91422 Mode 2 Transmit Unit supplies a single 1.544-MHz clock (Xmt Clk), which is selected when the digroup is looped.

3.97 The output of the clock selector, designated R-Clk′, is used by the framing circuits. Another 1.544-MHz clock (ClkR′) is derived by inhibiting R-Clk′ at the S-bit time slot in each frame with the D9 timing pulse. This clock synchronizes the receive unit timing signals and the channel unit decoders with the digroup pcm signal.

3.98 Digital Tone Generator. When a digroup is looped, Loop Cont goes high, enabling gates 8A and 9A or 8B and 9B (sheet 1) to supply D9 pulses to the digital tone generator. If both digroups are looped, D9 pulses from each digroup receive circuit are supplied to the same generator input, but these pulses are derived from the same clock (Xmt Clk) and therefore are synchronized.

Figure 3-15. 91431 Mode 1 Receive Unit, Circuit Diagram (Sheet 1 of 2)


D9
Phase Comparator
A
B
De-multiplexer
De-scrambler
Input Circuit
K1
+5V
45Ω
(J32)
P1
4
2
Loop A
511
+5V
511
12 dB Pad
13
11
Rcv A
Clock Inhibit
A
B
Clock Gen
D9 DF
3.152 MHz
10
Rcv Clk A
R-Clk' (1.576 MHz)
ClkR' (1.576 MHz with gaps)
8
WAC5 A'
D8
Sig D8
A B
(J32)
P1
PCMR-A'
18
Output Signal Selector
Dig Tn
Digital Tone Generator
D9
ClkR'
PCMR-B'
56
+5V
316
TONE
Green
+5V
ON
Tn Enbl'
7
OFF
Fr Sch
ClkR-A'
20
39
AC3-A
37
AC6-A'
ClkR-B'
48
A B A B
Sheet 2
Loop Cont to Sheet 2

91433 Mode 3 Receive Unit

3.99 The 91433 unit (figure 3-17) has input ports for the DS1 line signals of digroups A and B. These asynchronous 1.544-Mb/s signals are processed independently. Sheet 1 of figure 3-17 shows the inputs and outputs to the identical digroup A and B receive circuits detailed on sheet 2. Also on sheet 1 is the digital tone generator that serves both digroups.

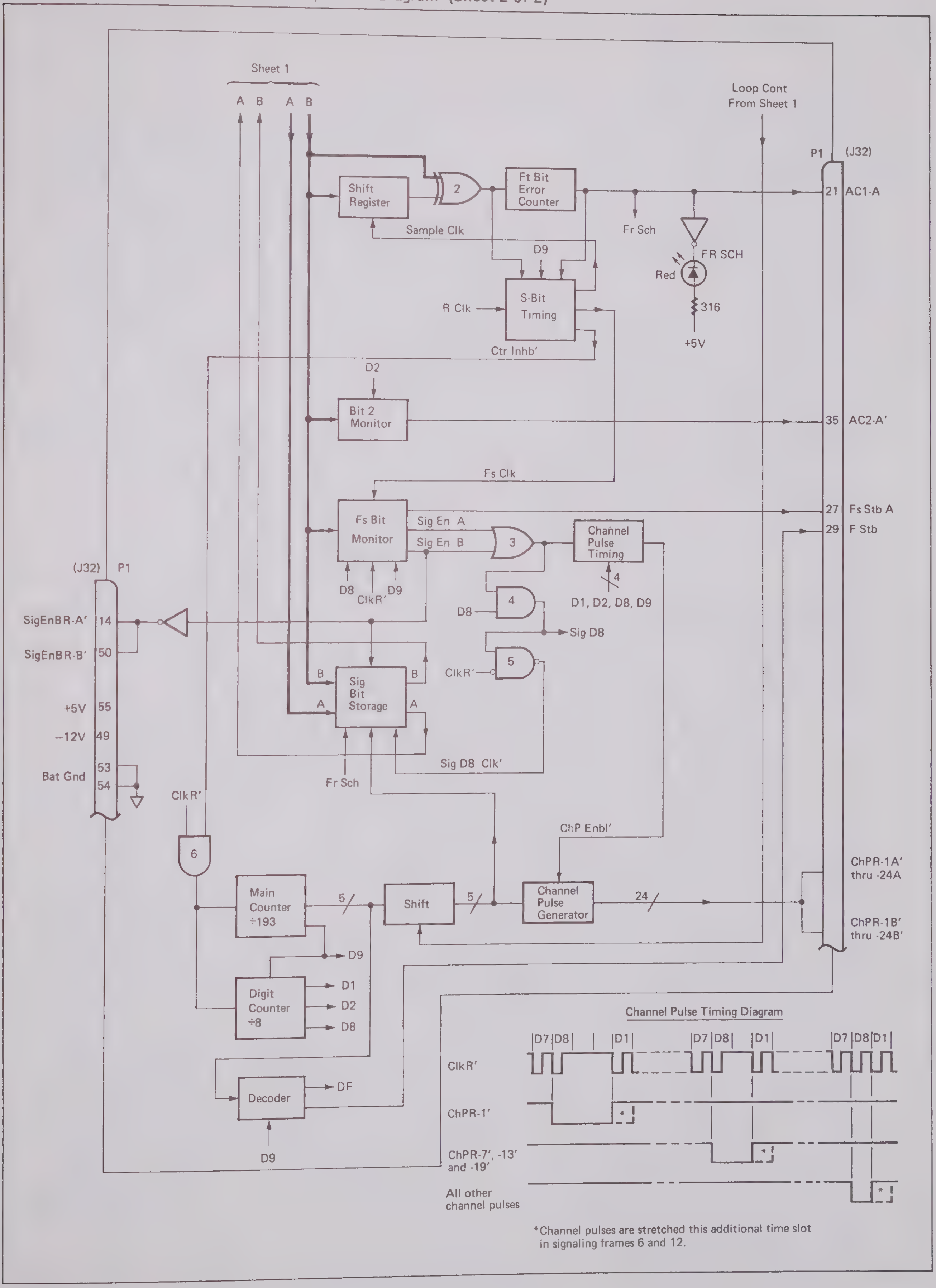
3.100 The main pcm signals and clocks in the digroup receive circuit and the digital tone generator are described below. The description of timing and control circuits begins at paragraph 3.108.

3.101 PCM Signal Flow. From the right side of figure 3-17, sheet 2, the bipolar 1.544-Mb/s DS1 signal goes through a 12-dB pad and a transformer that provide isolation and a balanced receive line termination. When the digroup is looped, control line WAC5′ goes low, operating the relay and switching the input circuit to the looped DS1 signal from the 91423 Mode 3 Transmit Unit. The two 511-ohm resistors are pullups for the open-collector gates on the transmit unit.

3.102 In the input circuit, the receive pcm signal is converted to unipolar format and a clock that is phase-locked to the pcm signal frequency is generated. In the absence of a receive pcm signal, the clock oscillator free-runs at 1.544 MHz nominal.

(Text continues on page 40.)

Figure 3-15. 91431 Mode 1 Receive Unit, Circuit Diagram (Sheet 2 of 2)


Sheet 1
A B A B
Loop Cont
From Sheet 1
P1 (J32)
Shift Register
2
Ft Bit Error Counter
21 AC1-A
Sample Clk
Fr Sch
D9
FR SCH
Red
R Clk
S-Bit Timing
316
+5V
Ctr Inhb'
D2
Bit 2 Monitor
35 AC2-A'
Fs Clk
Fs Bit Monitor
Sig En A
Sig En B
3
Channel Pulse Timing
27 Fs Stb A
29 F Stb
4
D8 ClkR' D9
D1, D2, D8, D9
D8
4
Sig D8
(J32) P1
SigEnBR-A' 14
SigEnBR-B' 50
+5V 55
−12V 49
Bat Gnd 53 54
B
A
Sig Bit Storage
B
A
ClkR'
5
Sig D8 Clk'
Fr Sch
ClkR'
ChP Enbl'
6
Main Counter ÷193
5
Shift
5
Channel Pulse Generator
24
ChPR-1A' thru -24A
ChPR-1B' thru -24B'
D9
Digit Counter ÷8
D1
D2
D8
Decoder
DF
D9
Channel Pulse Timing Diagram
D7 D8 D1 D7 D8 D1 D7 D8 D1
ClkR'
ChPR-1'
ChPR-7', -13' and -19'
All other channel pulses
*

*Channel pulses are stretched this additional time slot in signaling frames 6 and 12.

Figure 3-16. 91432 Mode 2 Receive Unit, Circuit Diagram (Sheet 1 of 2)

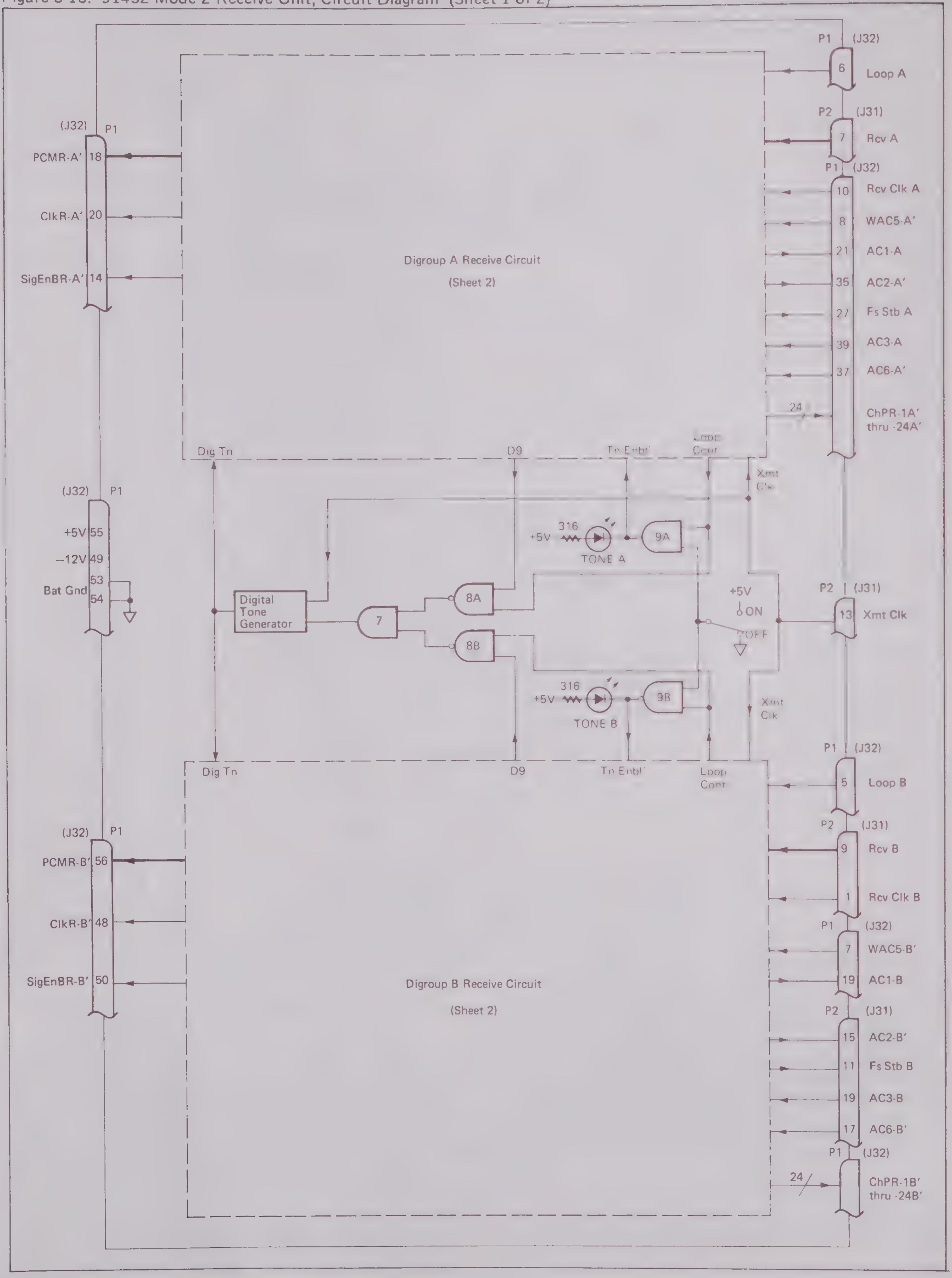

P1
(J32)
6
Loop A
P2
(J31)
7
Rcv A
P1
(J32)
10
Rcv Clk A
8
WAC5-A'
21
AC1-A
35
AC2-A'
27
Fs Stb A
39
AC3-A
37
AC6-A'
24
ChPR-1A' thru -24A'
(J32)
P1
PCMR-A'
18
ClkR-A'
20
SigEnBR-A'
14
Digroup A Receive Circuit
(Sheet 2)
Dig Tn
D9
Tn Enbl
Loop Cont
Xmt Clk
(J32)
P1
+5V
55
–12V
49
53
Bat Gnd
54
316
+5V
TONE A
9A
Digital Tone Generator
7
8A
8B
+5V
ON
OFF
P2
(J31)
13
Xmt Clk
316
+5V
TONE B
9B
Xmt Clk
Dig Tn
D9
Tn Enbl
Loop Cont
P1
(J32)
5
Loop B
P2
(J31)
9
Rcv B
1
Rcv Clk B
P1
(J32)
7
WAC5-B'
19
AC1-B
P2
(J31)
15
AC2-B'
11
Fs Stb B
19
AC3-B
17
AC6-B'
P1
(J32)
24
ChPR-1B' thru -24B'
(J32)
P1
PCMR-B'
56
ClkR-B'
48
SigEnBR-B'
50
Digroup B Receive Circuit
(Sheet 2)

Figure 3-16. 91432 Mode 2 Receive Unit, Circuit Diagram (Sheet 2 of 2)

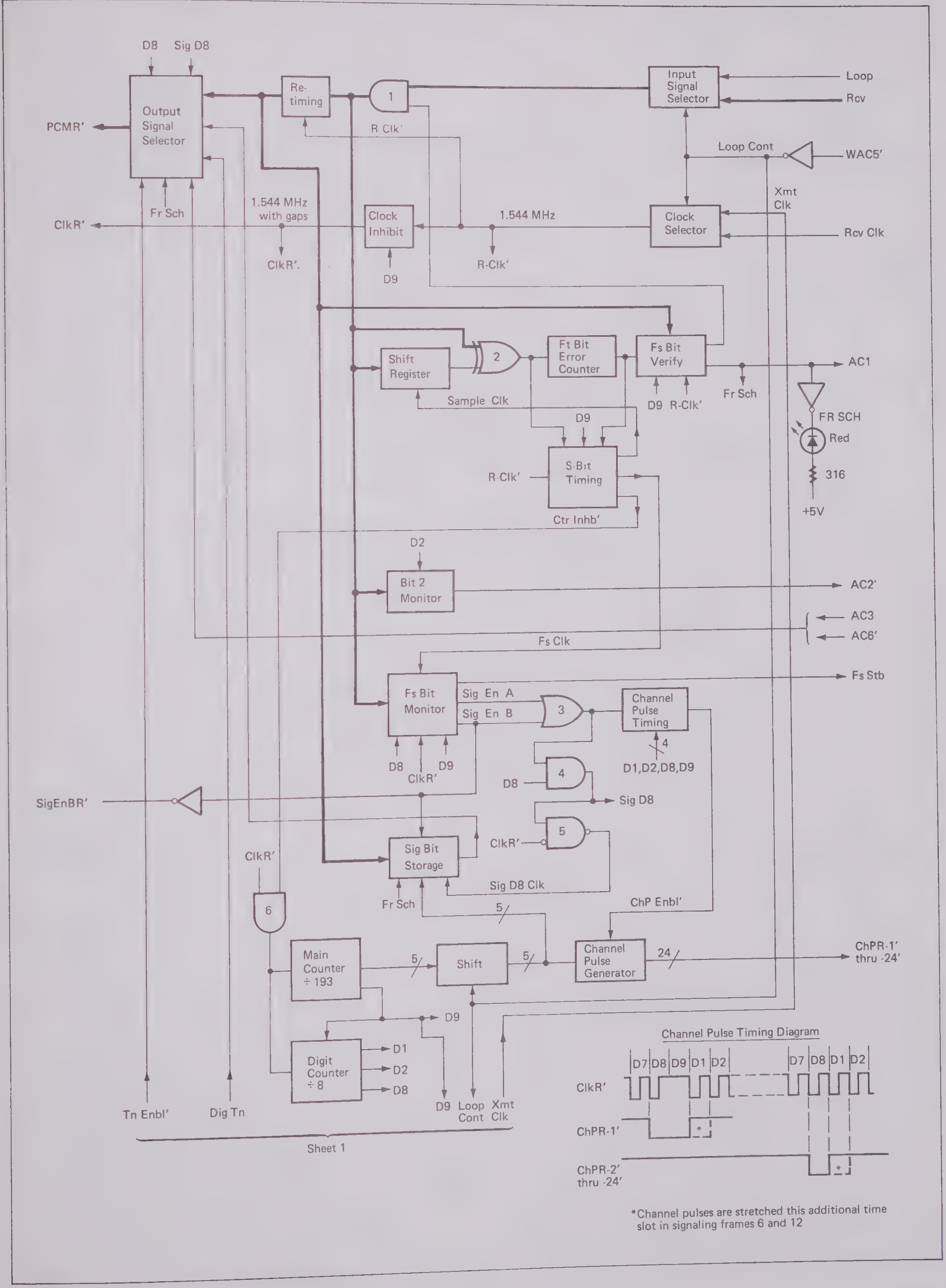

D8
Sig D8
Output Signal Selector
PCMR′
Re-timing
1
R Clk′
Input Signal Selector
Loop
Rcv
Loop Cont
WAC5′
Xmt Clk
Fr Sch
1.544 MHz with gaps
ClkR′
Clock Inhibit
1.544 MHz
Clock Selector
Rcv Clk
ClkR′.
D9
R-Clk′
Shift Register
2
Ft Bit Error Counter
Fs Bit Verify
AC1
Sample Clk
D9
D9 R-Clk′
Fr Sch
FR SCH
Red
316
+5V
R-Clk′
S-Bit Timing
Ctr Inhb′
D2
Bit 2 Monitor
AC2′
AC3
AC6′
Fs Clk
Fs Stb
Fs Bit Monitor
Sig En A
Sig En B
3
Channel Pulse Timing
4
D1,D2,D8,D9
D8
D9
ClkR′
D8
4
Sig D8
SigEnBR′
5
ClkR′
ClkR′
Sig Bit Storage
Sig D8 Clk
Fr Sch
5
ChP Enbl′
6
Main Counter ÷ 193
5
Shift
5
Channel Pulse Generator
24
ChPR-1′ thru -24′
D9
Digit Counter ÷ 8
D1
D2
D8
Tn Enbl′
Dig Tn
D9
Loop Cont
Xmt Clk
Sheet 1
Channel Pulse Timing Diagram
D7
D8
D9
D1
D2
D7
D8
D1
D2
ClkR′
ChPR-1′
ChPR-2′ thru -24′
*
*
*Channel pulses are stretched this additional time slot in signaling frames 6 and 12

Figure 3-17. 91433 Mode 3 Receive Unit, Circuit Diagram (Sheet 1 of 2)

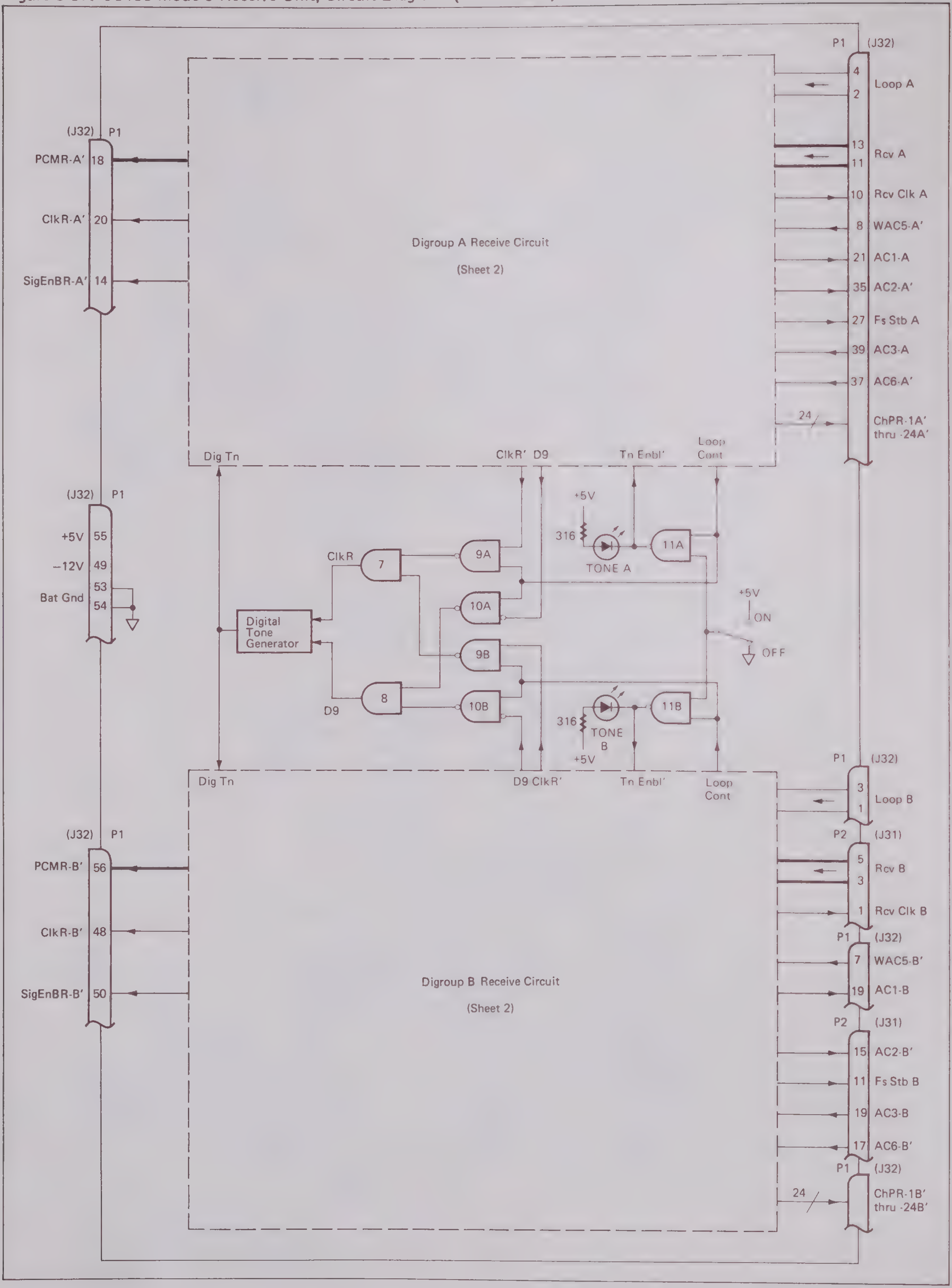
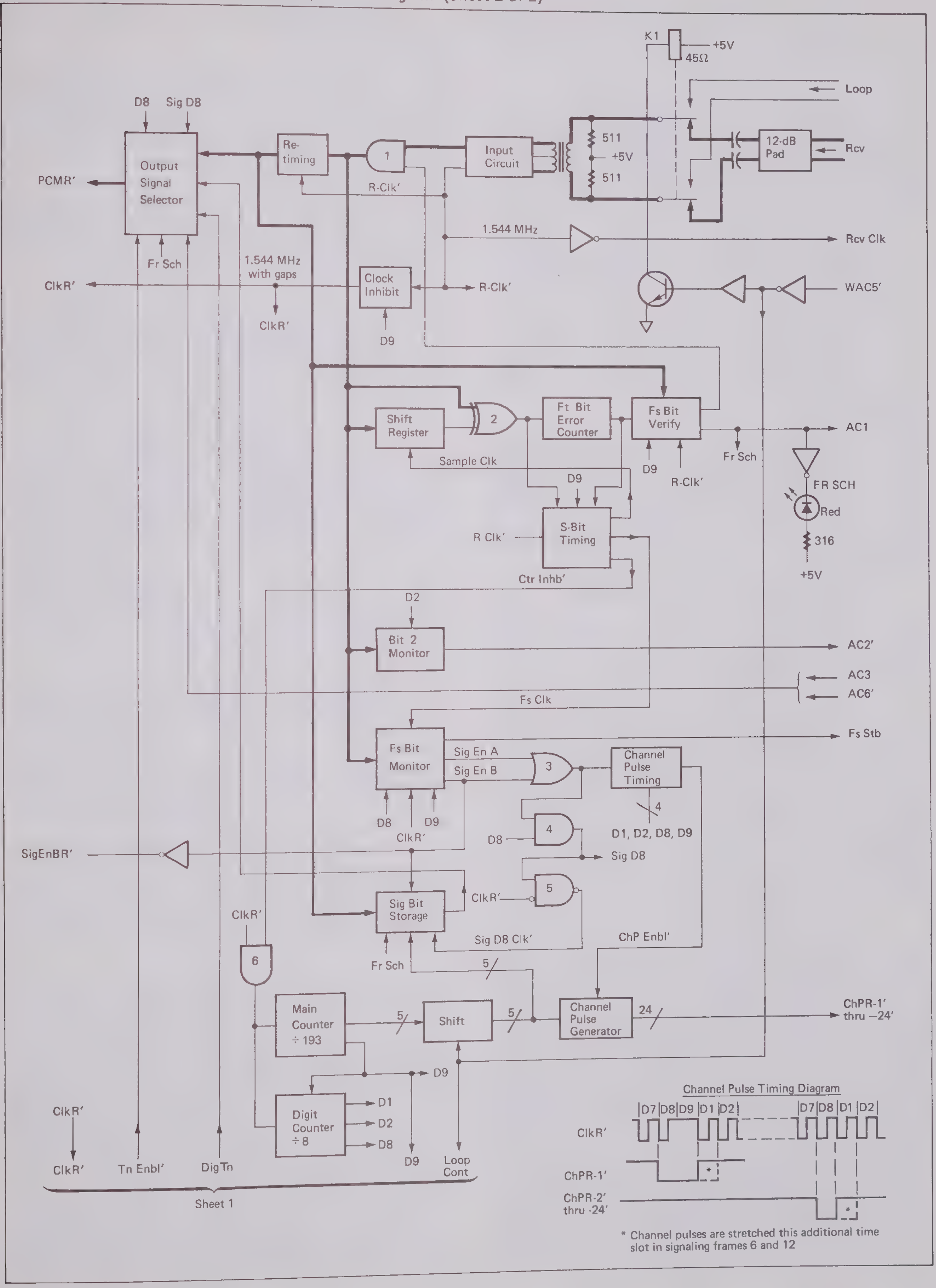

P1
(J32)
4
2
Loop A
13
11
Rcv A
10
Rcv Clk A
8
WAC5-A'
21
AC1-A
35
AC2-A'
27
Fs Stb A
39
AC3-A
37
AC6-A'
24
ChPR-1A'
thru -24A'
(J32)
P1
PCMR-A'
18
ClkR-A'
20
SigEnBR-A'
14
Digroup A Receive Circuit
(Sheet 2)
Dig Tn
ClkR'
D9
Tn Enbl'
Loop
Cont
(J32)
P1
+5V
55
–12V
49
53
Bat Gnd
54
+5V
316
TONE A
11A
ClkR
7
9A
10A
9B
10B
8
D9
Digital
Tone
Generator
+5V
ON
OFF
316
TONE
B
+5V
11B
Dig Tn
D9
ClkR'
Tn Enbl'
Loop
Cont
P1
(J32)
3
1
Loop B
P2
(J31)
5
3
Rcv B
1
Rcv Clk B
P1
(J32)
7
WAC5-B'
19
AC1-B
P2
(J31)
15
AC2-B'
11
Fs Stb B
19
AC3-B
17
AC6-B'
P1
(J32)
24
ChPR-1B'
thru -24B'
(J32)
P1
PCMR-B'
56
ClkR-B'
48
SigEnBR-B'
50
Digroup B Receive Circuit
(Sheet 2)

Figure 3-17. 91433 Mode 3 Receive Unit, Circuit Diagram (Sheet 2 of 2)


K1
+5V
45Ω
Loop
D8
Sig D8
Output Signal Selector
Re-timing
1
Input Circuit
511
+5V
511
12-dB Pad
Rcv
PCMR'
R-Clk'
1.544 MHz
Rcv Clk
Fr Sch
1.544 MHz with gaps
ClkR'
Clock Inhibit
R-Clk'
WAC5'
ClkR'
D9
Shift Register
2
Ft Bit Error Counter
Fs Bit Verify
AC1
Sample Clk
D9
Fr Sch
D9
R-Clk'
FR SCH
Red
R Clk'
S-Bit Timing
316
+5V
Ctr Inhb'
D2
Bit 2 Monitor
AC2'
AC3
AC6'
Fs Clk
Fs Stb
Fs Bit Monitor
Sig En A
Sig En B
3
Channel Pulse Timing
4
D8
D9
ClkR'
D8
4
D1, D2, D8, D9
SigEnBR'
Sig D8
5
ClkR'
Sig Bit Storage
ClkR'
Sig D8 Clk'
ChP Enbl'
6
Fr Sch
5
Main Counter ÷ 193
5
Shift
5
Channel Pulse Generator
24
ChPR-1' thru –24'
D9
Digit Counter ÷ 8
D1
D2
D8
ClkR'
ClkR'
Tn Enbl'
Dig Tn
D9
Loop Cont
Sheet 1
Channel Pulse Timing Diagram
D7
D8
D9
D1
D2
D7
D8
D1
D2
ClkR'
ChPR-1'
ChPR-2' thru -24'
*
*
* Channel pulses are stretched this additional time slot in signaling frames 6 and 12

(Continued from page 34.)

3.103 The pcm signal passes through gate 1 (paragraph 3.119) to the retiming circuit. Normally, the retimed signal goes through the output signal selector to the channel units of the digroup via the PCMR′ bus. The format is nonreturn-to-zero (nrz).

3.104 Activation of one of the four control lines to the selector alters the vf and/or signaling bits or inserts a digital tone as described in paragraph 3.109. Control lines AC3 and AC6′ from the 91420 Alarm Control Unit are activated by a remote alarm and system alarm, respectively. Fr Sch becomes active when frame sync is lost. Tn Enbl′ is active while the digroup is looped if the ON/OFF switch is set to ON.

3.105 Clocks. The 1.544-MHz recovered clock from the input circuit (sheet 2) is fed over the Rcv Clk A or B line to the 91423 Mode 3 Transmit Unit where it is available for use in the looped receive clock option. The 1.544-MHz clock designated R-Clk′ is used by the framing circuits.

3.106 The 1.544-MHz clock designated ClkR′ is derived by inhibiting R-Clk′ at the S-bit time slot in each frame with the D9 timing pulse. This clock synchronizes the receive unit timing signals and the channel unit decoders with the digroup pcm signal.

3.107 Digital Tone Generator. When a digroup is looped, Loop Cont goes high enabling gates 9A and 10A or 9B and 10B (sheet 1) to supply ClkR through gate 7 and D9 pulses through gate 8 to the digital tone generator. If both digroups are looped, ClkR and D9 from each digroup receive circuit are gated together, but the corresponding signals are synchronized.

Receive Unit Timing and Control Circuits

3.108 The circuits described below are almost identical on the three types of receive units. They appear on sheet 2 of figures 3-15 (mode 1), 3-16 (mode 2), and 3-17 (mode 3).

3.109 Output Signal Selector. On the mode 2 and mode 3 receive units, the selector has one section with three signal inputs and one signal output (PCMR′); see sheet 2 of figures 3-16 and 3-17. On the mode 1 receive unit, the selector has duplicate sections, one for each digroup; see sheet 1 of figure 3-15. The main input is the received pcm signal, which consists of vf information bits 1-7/8 in frames 1 through 12 and signaling bit 8 in frames 6 and 12. The other two inputs are digital tone and stored signaling bit 8's. All three signals are for 24 channels.

NOTE: The expression "bits 1-7/8" means bits 1-7 in frames 6 and 12 and bits 1-8 in the other frames.

3.110 The output signal is determined by the status of four control lines: Fr Sch (frame search), AC3 (remote alarm), AC6′ (system alarm), and Tn Enbl′. AC3 and AC6′ are from the 91420 Alarm Control Unit; Fr Sch and Tn Enbl′ are created within the receive unit. As indicated on line 1 of figure 3-18, with all control lines normal, the received pcm signal goes directly through the selector to the output.

3.111 Lines 2 and 3 of figure 3-18 show the effect of a loss of frame synchronization. First, Fr Sch goes to the search state, forcing vf bits 1-7 in all frames to logic 0 (vf mute). Signaling bit 8's are obtained from storage and inserted in all frames, not just frames 6 and 12. That is, stored bit 8 of frame 6 is also inserted in frames 7-11 and stored bit 8 of frame 12 is also inserted in frames 1-5. If reframing is not completed within 2.5 seconds, a system alarm takes place and AC6′ goes to logic 0. Now, bit 8 in all frames is forced to logic 0 (idle); vf bits remain muted as long as the out-of-frame condition persists.

3.112 Line 4 of figure 3-18 shows the remote alarm condition: AC3 is logic 1 and AC6′ is logic 0. The vf bits 1-7/8 are forced to logic 0 (vf mute) and signaling bit 8's are forced to logic 0 (idle).

3.113 Line 5 of figure 3-18 shows conditions applicable when the digroup is in looped terminal (LT) or looped line (LL) status. The condition shown is a system alarm (AC6′ at logic 0), but no remote alarm or local alarm. The vf bits 1-7/8 of the received pcm signal are passed through the selector but signaling bit 8's are forced to logic 0 (idle).

3.114 With the channel bank in LT status, setting the ON/OFF slide switch on the receive unit to ON lights the green TONE indicator and produces the conditions of line 6 in figure 3-18. Digital tone is inserted as vf bits 1-7/8 in all 24 channels and signaling bit 8's are forced to idle.

3.115 Framing Circuit. As shown in figure 2-4A, the basic digroup frame consists of an S-bit followed by 192 data bits (8 bits × 24 channels = 192). The S-bit in odd-numbered frames 1 through 11 is the terminal framing bit (Ft) and has a 101010 pattern. The S-bit in even-numbered frames 2 through 12 is the signaling framing bit (Fs) and has a 001110 pattern. The 12-frame period is called a "superframe."

3.116 The function of the framing circuit is to find the alternating 1/0 pattern of the Ft bits and synchronize the local counters with it. When the receive unit is in-frame, the incoming bit from the Ft time slot and the seven following bits are stored in a shift register. (The time slot locations are based on the local counters.) At the next Ft bit time slot two frames later, the present Ft bit is compared with the stored Ft bit by exclusive-OR gate 2; if they have the same state (0 or 1), an error is tallied. If more than two out of five consecutive comparisons produce errors, the framing circuit goes into the search mode. The Fr Sch lead and the external AC1 lead go to logic 1, and the FR SCH indicator lights.

3.117 In the frame search mode, the eight stored bits are compared with the corresponding bits two frames later, one at a time. The local counters are disabled at gate 6. When a comparison is correct (bits have opposite states), the local counters are enabled and the next comparison is made two frames later. If all eight comparisons are incorrect, the next eight bits are stored in the shift register, the counters are enabled to run ahead two frames, and the process is repeated.

3.118 If 10 consecutive bits at the same location in alternate frames have opposite values, this location is assumed to be the Ft bit time slot and the receive unit is considered "in-frame." The main counter runs without interruption, Fr Sch and AC1 go to logic 0, and the FR SCH indicator goes dark. Once a failed pcm signal has restored to normal, typical reframe time is less than 50 ms.

3.119 Fs Bit Verification. Certain types of channel vf signals may contain a 1/0 data bit pattern in alternate frames of the 1.544-Mb/s pcm signal; for example, bit 1 of a 2-kHz tone at any level, or bits 4 and 8 of a 1-kHz tone at 0 dBm0. To prevent the framing circuit from locking onto the data bits, an additional circuit to verify the Fs bit pattern is provided on the mode 2 and mode 3 receive units. After framing on the supposed Ft bits has been established but before Fr Sch goes normal, the verification circuit searches for the Fs bit pattern. If it is not found in 32 frames, the incoming data is blocked at gate 1 to force a reframing cycle.

3.120 S-Bit Timing. Three timing signals associated with Ft and Fs bit recognition are generated as follows:

(a) Sample Clock. Normally, this signal consists of eight clock pulses every other frame. In the frame search

Figure 3-18. Receive Unit Output Under Normal, Alarm, and Test Conditions

Line	Status of Control Inputs (blank = normal)				PCM Signal Output (*)
	Fr Sch	AC3	AC6'	Tn Enbl'	
1					Vf bits 1-7/8 and sig bit 8 same as received pcm.
2	Search				Vf bits 1-7 muted; bit 8 from sig bit storage.
3	Search		Alarm		Vf bits 1-7 muted; bit 8 idle.
4		Alarm	Alarm		Vf bits 1-7/8 muted; sig bit 8 idle.
5			Alarm		Vf bits 1-7/8 same as received pcm; sig bit 8 idle.
6			Alarm	On	Vf bits 1-7/8 digital tone; sig bit 8 idle.

*Vf bits 1-7/8 means bits 1-7 in frames 6 and 12 and bits 1-8 in all other frames. Sig bit 8 means bit 8 in frames 6 and 12.

mode, according to the Ft bit comparison at gate 2, the signal consists of 8 to 16 clock pulses every other frame.

(b) Counter Inhibit. During frame search, this signal stalls the main counter and digit counter for up to eight clock cycles every other frame.

(c) Fs Clock. This signal enables the Fs bit monitor during even-numbered frames.

3.121 Bit 2 Monitor. The bit 2 time slots in the receive pcm signal are sampled by D2 pulses and the resultant AC2′ signal is sent to the 91420 Alarm Control Unit. In normal operation, AC2′ consists of random 5.2-μs positive pulses, one for each channel word that has bit 2 in state 1. During a local alarm at the distant channel bank, all bit 2's are transmitted as 0's. In response, AC2′ at the near channel bank goes to steady logic 0 to initiate a remote alarm.

3.122 Fs Bit Monitor. The Fs bits in the incoming pcm signal are detected and stored for one frame. From the Fs bit pattern, the following timing signals are developed:

(a) Sig En A and Sig En B. These signals are logic 1 during the A and B signaling frames, respectively. Sig En B is inverted and distributed to the channel units as SigEnBR-A′ to digroup A and SigEnBR-B′ to digroup B.

(b) Fs Stb. This signal is a logic 1 pulse during the Fs bit time slot. It is sent to the optional 91448 Office Interface for possible future applications that require phase synchronization of the Fs patterns in the A and B digroups.

3.123 Additional combinational logic involving gates 3, 4, and 5 produces the Sig D8 and Sig D8 Clk′ timing signals. Sig D8 is logic 1 during the bit 8 time slots of signaling frames 6 and 12. Sig D8 Clk′ is logic 0 during the last half of Sig D8.

3.124 Signaling Bit Storage. In normal operation, signaling bit 8's from the received pcm signal of each digroup are written into a random access memory (RAM) of one-bit cells arranged in a matrix of 24 rows by 32 columns. Each row is assigned to one channel and each pair of columns stores the signaling bits of one superframe. The odd- and even-numbered columns of the pairs are for the A and B signaling bits, frames 6 and 12, respectively.

3.125 The RAM cells are addressed in a continuous sequence so that stored data is updated every 16 superframes. In generating RAM addresses, columns are selected by a four-bit counter driven by Sig En B, and rows are selected by the five binary outputs of the main counter.

3.126 When frame synchronization is lost and Fr Sch goes high, writing into RAM is halted and stored data is read out nondestructively to the ouput signal selector. For a maximum of six frames, data is read from the pair of columns that was being addressed when Fr Sch went high. Then, the address jumps ahead to the pair of columns that contains data stored 16 superframes previously. Data is read out of this pair and accepted by the output signal selector in all frames, not just frames 6 and 12. The stored A signaling bits are read out in frames 6 through 11 and the stored B signaling bits are read out in frames 12 and 1 through 5.

3.127 If reframing is completed in less than 2.5 seconds, the output signal selector immediately goes back to current information. If reframing is not completed in 2.5 seconds, the 91420 Alarm Control Unit initiates a system alarm and AC6′ goes low. Until the system alarm clears, the output signal selector forces signaling bit 8's low in all frames.

3.128 Counters. The main counter has five binary outputs, which are decoded by the channel pulse generator to produce 24 channel receive pulses, ChPR-1′ through ChPR-24′. When the the channel bank is looped, WAC5′ from the alarm control unit goes low and the Loop Cont signal shifts the five binary outputs to create a 12-channel offset between receive and transmit channel pulses. Now, for example, channels 1 and 13 "talk" to each other through the looped back digital pulse stream. Signaling is forced on-hook during looped terminal (LT) status.

3.129 The main counter also outputs a 648-ns D9 pulse at count 193 that marks the S-bit time slot. The digit counter generates 648-ns pulses at the time slots for bits 1, 2, and 8 of the receive channel words.

3.130 On the mode 1 receive unit, the five binary outputs of the main counter are decoded to create DF and F Stb signals. DF is logic 1 during the F-bit time slots, which precede bit 1 of channel words 1, 7, 13, and 19. F Stb, which is supplied to the optional 91448 Office Interface Unit for possible future applications, is logic 1 during the second half of the 648-ns DF pulses.

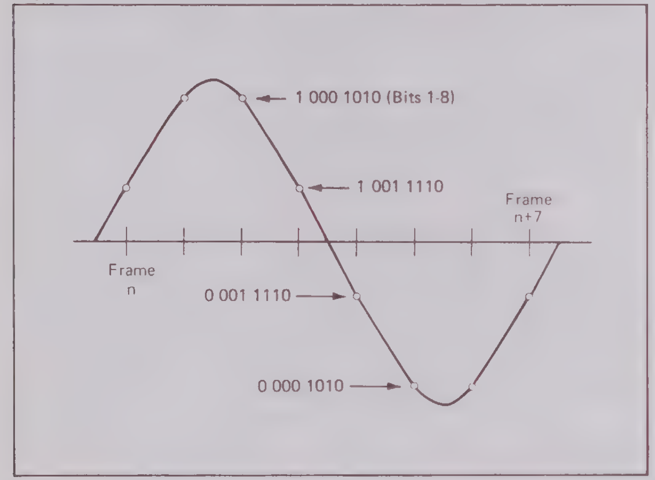
3.131 Channel pulse width is controlled by ChP Enbl′. As shown in the timing diagram at the bottom of sheet 2, most channel pulses are one time slot wide during nonsignaling frames and two time slots wide during signaling frames. The extra width during signaling frames tells the channel unit codecs to process bit 8 as a signaling bit. Additional width is provided where necessary to accommodate framing bits. This is applicable to channel pulse 1 in all modes because of the S-bit, and to channel pulses 1, 7, 13, and 19 in mode 1 because of the F-bits.

3.132 During frame search, channel pulse ChPR-1′ is stretched because the main counter is stopped after the 193rd bit for up to eight clock cycles. Also during frame search, ChP Enbl′ is stretched one clock cycle every frame so that the codec processes all bit 8's as signaling bits.

3.133 Digital Tone Generator. The digital tone generator, which appears on sheet 1, is clocked by ClkR′ (mode 1, 3) or Xmt Clk (mode 2) and frame synchronized by D9. The generator output is a repetitive eight-frame sequence of channel words that are decoded by each of the 24 channel units in the digroup as a 1-kHz analog tone at 0 dBm0.

3.134 Figure 3-19 shows one cycle of the analog tone and the channel words in the eight frames. In frame n, the word 1 001 1110 is output 24 times in succesion, once for each channel. In frame n+1, the output changes to 1 000 1010 repeated 24 times. And so on. Polarity bit 1 is 1 in the positive half-cycle and 0 in the negative half-cycle. The pattern of bits 2-8 has just two variations: 001 1110 and 000 1010.

Figure 3-19. Digital Tone Generator Codes



91426 Syndes Unit

3.135 The main printed circuit board of the syndes unit contains the receive section and the alarm and loopback circuits. The transmit section is on another board, pn 087-56942-01; this board has a 10-pin connector P51 that mates with receptacle J1 on the main board. The two printed circuit boards are shown in figure 2-2. Figure 3-20 is the circuit diagram..

3.136 In the transmit section, the digroup A and B pcm signals are combined and control bits inserted. The output is a 3.152-Mb/s DS1C digital line signal with M1C-compatible format. The transmit section is shown in figure 3-20A and the description begins in paragraph 3.142.

3.137 The incoming DS1C signal goes through a 15-dB pad and contacts of relay K1 to the receive section. There, the signal is demultiplexed into digroup A and B pcm signals. Although the digroup transmit signals are synchronized, the digroup receive signals need not be synchronized. The receive section is shown in figure 3-20B and the description begins in paragraph 3.152.

3.138 Alarm Circuits. If F-bit or M-bit synchronization is lost, the In-Frame lead from the receive section goes low to initiate a local alarm. After 200 ms, the LOCAL indicator lights and control bit M4 of the outgoing DS1C signal is forced to 0 as an alarm indication to the far terminal.

3.139 If control bit M4 of the incoming DS1C signal is 0, the Rem Alm lead from the receive section goes high and, unless gate 1 has been inhibited by a local alarm, the REMOTE indicator lights.

3.140 Loopback Circuits. Depressing the TEST pushbutton grounds the LP Req′ (loop pulse request) line to the alarm control units. If either or both digroups is in looped terminal (LT) status, a 300-ms pulse is returned on the LP′ line from the alarm control units. Relay K1 operates momentarily to open the receive line and bridge the DS1C receive section input to the transmit line through a 20-dB pad. The pulse also unloops the looped digroup(s) momentarily.

3.141 If the syndes unit reframes on the looped DS1C signal, and if both digroups reframe in the receive unit, the gate 2 output goes low. (AC1-A and -B from the receive unit are low when digroups A and B, respectively, are in-frame.) Typically, reframe time is less than 16 ms in the syndes unit and less than 50 ms in the receive unit. At the end of the 300-ms LP′ pulse, the PASS indicator lights if the syndes unit and receive unit are in-frame. Otherwise, the FAIL indicator lights. Releasing the TEST pushbutton extinguishes the lighted indicator.

NOTE: If only one digroup is in LT status for this test, the momentary break in the DS1C receive signal will not cause a system alarm in the other digroup, although there will be a 300-ms service interruption.

Syndes Unit, Transmit Section

3.142 Transmit PCM Signals. The dual elastic store (figure 3-20A, upper left) is a timing buffer between the synchronous digroup bit streams from the mode 2 transmit unit and the high-speed DS1C bit stream to the digital line. The elastic store for each digroup has eight cells with addresses 0 through 7. Data enters the elastic store under control of the write counter, which generates addresses 0 through 7 in a continuous sequence at 1.544 Mb/s. The read counter also generates addresses, but at 1.576 Mb/s and with gaps that provide a control bit time slot every 53rd clock cycle.

3.143 Normally, there is a four-bit delay through the elastic store; for example, data is read out of cell 7 while data is being read into cell 3. If the delay becomes less than four bits, the address comparator activates the two outputs of the stuff control. One output causes the control bit selector to force the C-bits in the next two subframes to 1's as an indication to the far terminal that the subframe contains a stuffed bit. The other output modifies the read sequence so that one cell is read twice; the second reading is in effect a dummy bit that is "stuffed" into the bit stream.

3.144 As shown in figure 2-4E, the stuffed bit is in the third time slot of the applicable digroup following the third C-bit (Cc) in the subframe. When stuffing is required, digroup A is stuffed in subframe M1 or M3 and digroup B is stuffed in subframe M2 or M4. Because the digroups are synchronized, stuffing always takes place in two subframes: M1 and M2 or M3 and M4 (or in all four).

3.145 One multiframe of the DS1C digital line signal has 1,272 bits, including 24 control bits and a maximum of 2 stuffed bits in each digroup. For a 3.152-MHz clock rate, the maximum and minimum data rates of the digroup signals into the dual elastic store are derived as follows.

(a) Multiframes/second = 3,152,000 ÷ 1,272 = 2,478

(b) Control bit rate = 2,478 × 24 = 59,472 b/s

(c) Maximum digroup data rate (zero stuffing) = (3,152,000 − 59,472) ÷ 2 = 1,546,264 b/s

(d) Maximum stuffing rate per digroup = 2,478 × 2 = 4,956 b/s

(e) Minimum digroup data rate (maximum stuffing) = 1,546,264 − 4,956 = 1,541,308 b/s

3.146 The Xmt Intlk line is normally grounded at pin 43 in the mode 2 transmit unit. If that unit is unplugged, the output of the dual elastic store is forced to all 1's and the stuffing rate is set at one-half the maximum by stuffing only during subframes M1 and M2. This results in transmitted digroup signals of 1,543,786 b/s.

3.147 Digroups A and B are clocked out of the elastic store by the 1.576-MHz clock and its complement. The two bit streams are interleaved to form a 3.152-Mb/s signal with every 53rd time slot reserved for a control bit.

3.148 The combined bit stream is scrambled (paragraph 3.52), control bits are inserted, and the signal is retimed to produce a return-to-zero signal. The bipolar converter routes alternate 1's to the two halves of the center-tapped transformer so that consecutive output pulses have opposite polarity.

3.149 Control Bit Selector. The control bit selector decodes the three binary outputs of the control bit counter to select the applicable control bit from the six input ports as listed below. The sequence is M, Ca, F0, Cb, Cc, and F1.

(a) The normal pattern from the M-bit generator is 0111 in subframes M1 through M4, respectively, but changes to 0110 when Rem Alm goes high.

(b) Ca, Cb, and Cc are 0 in unstuffed subframes and 1 in stuffed subframes.

(c) F0 is fixed at 0 by zero volts (ground) and F1 is fixed at 1 by +5V.

3.150 Timing. The DS1C transmit frequency is controlled by a 3.152-MHz clock and the frame format is established by a string of tandem counters. The bit counter places a control bit time slot after every 52 data bits, the control bit counter places the six control bits in each subframe, and the subframe counter determines the length of the multiframe (four subframes).

3.151 The output of the first stage in the bit counter is 1.576-MHz, half the rate of the 3.152-MHz clock. The waveform, which in figure 3-20A is labeled "1.576 MHz with gaps," has an extra half-cycle between bit 52 and bit 1 that provides the control bit time slots.

Syndes Unit, Receive Section

3.152 Receive PCM Signal. In the input circuit (figure 3-20B, upper right), the DS1C receive pcm signal is converted from bipolar to unipolar and a 3.152-MHz clock with its rising edges phase-locked to the center of the data bits is recovered. The retiming circuit produces a nonreturn-to-zero signal, and the descrambler restores the data to the state at which it entered the scrambler at the transmit terminal. The timing signal from the bit counter output causes the descrambler to reject control bits.

3.153 In the demultiplexer, data is separated into A and B digroup bit streams; stuffed bits are rejected. No attempt is made to adjust for jitter caused by removal of control bits and stuffed bits.

3.154 Digroup Clock Generator. The two receive clocks, A and B, are each obtained from a flip-flop that is set and reset on alternate cycles of the 3.152-MHz clock. An intermediate output of the bit counter steers the clock pulses alternately to the two flip-flops. The resulting 1.576-MHz A and B clocks are of opposite phase and modified as follows:

(a) Timing signals from the subframe counter and the C-bit detector prevent clock pulses during stuffed bit time slots.

(b) The bit counter output prevents clock pulses during control bit time slots.

3.155 Timing Signals. Timing signals in the receive section are controlled by the 3.152-MHz clock and developed in accordance with the frame format by a string of tandem counters. The bit counter emits a one-cycle pulse every 53 clock cycles; the count is inhibited during frame search or extended one count by a false frame inhibit.

3.156 The control bit counter produces clock edges during the center of the F, C, and M control bit time slots. Some additional timing signals produced during specific intervals but not shown on figure 3-20B are: (1) between M and Ca, (2) between Ca and F0, and (3) between Cc and F1.

3.157 The subframe counter is clocked midway between M-bits to count the four subframes. Output pulses occur during M1 and M3 subframes.

3.158 During normal operation, the multiframe counter produces an output pulse every 8 multiframes and another every 16 multiframes. Counting is suspended when F is out-of-frame.

3.159 C-Bit Detector. The C-bit detector monitors the main receive signal bus. If the majority of C-bits in a subframe are 1's, the output (Destuff Enbl) goes high four clock cycles after Cc and returns low six clock cycles after Cc. This provides the proper timing to inhibit clock pulses from the digroup clock generator during destuffing.

3.160 Frame Search. As shown in figure 2-4D, F-bits are separated by 156 data bits (3 × 52) plus 2 control bits, and the F-bits have an alternating 1/0 pattern. When F is inframe, consecutive F-bits are compared by exclusive-OR gate 3 and if they have the same state (0 or 1), an error pulse results. If there are more than three errors in the eight F-bits of a multiframe, the F-bit error counter output goes low to initiate a frame search. The first step in the search is finding the F-bit pattern.

3.161 When F is out-of-frame, the data bit from the F-bit time slot and the seven following bits are stored in a shift register. (The time slot locations are based on the local counters.) At the next F-bit time slot, eight new bits replace the eight bits stored in the shift register, one at a time, and corresponding bits are compared.

3.162 If the first bit comparison is correct, that bit and the next seven bits are stored, and the search moves to the next F-bit time slot location. If the comparison is incorrect (both bits are 1's or 0's), the local bit counter is inhibited for one clock cycle, which shifts the alignment of the local receive

(Text continues on page 46.)

Figure 3-20. 91426 Syndes Unit, Circuit Diagram (Sheet 1 of 2)

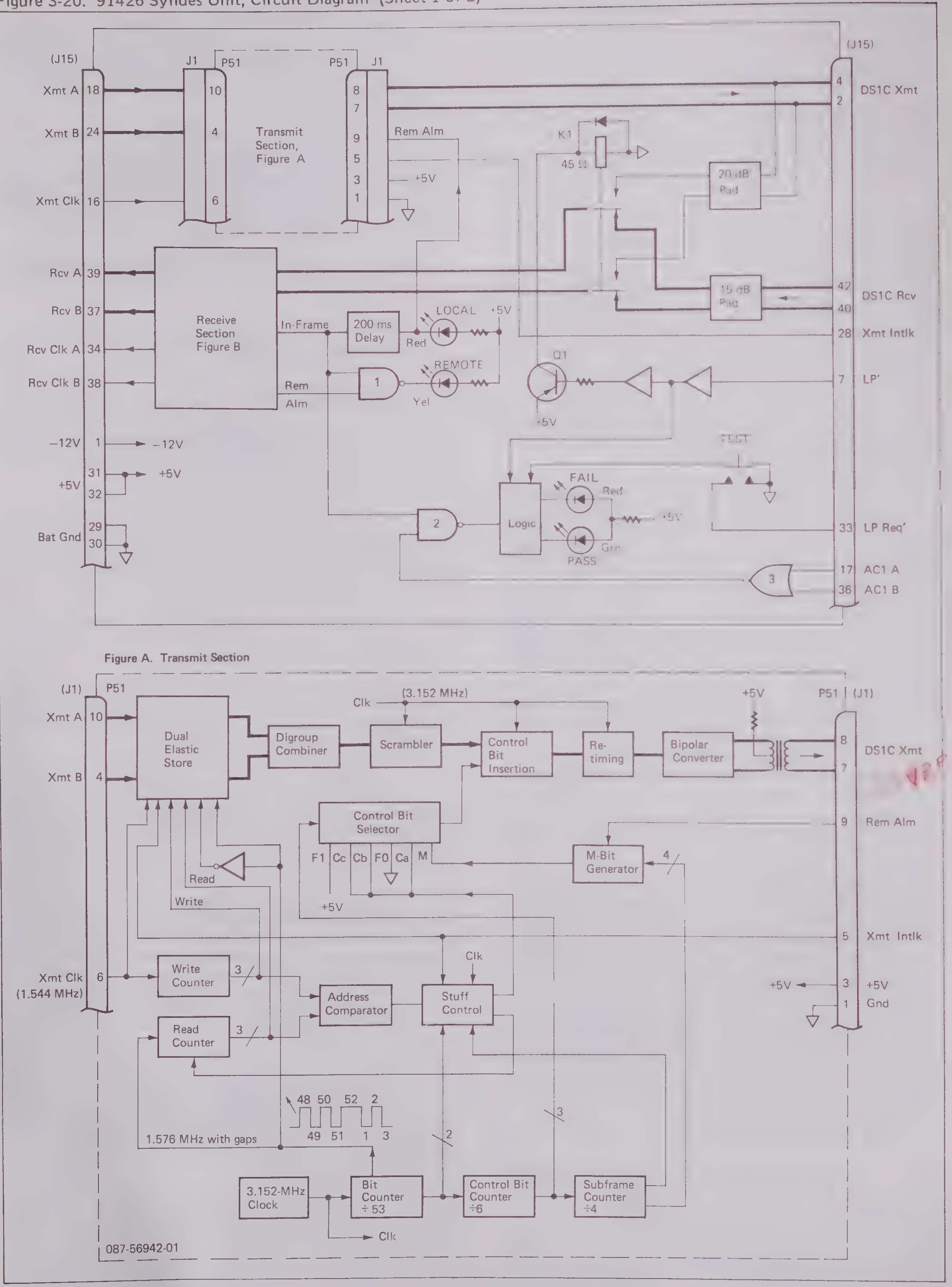
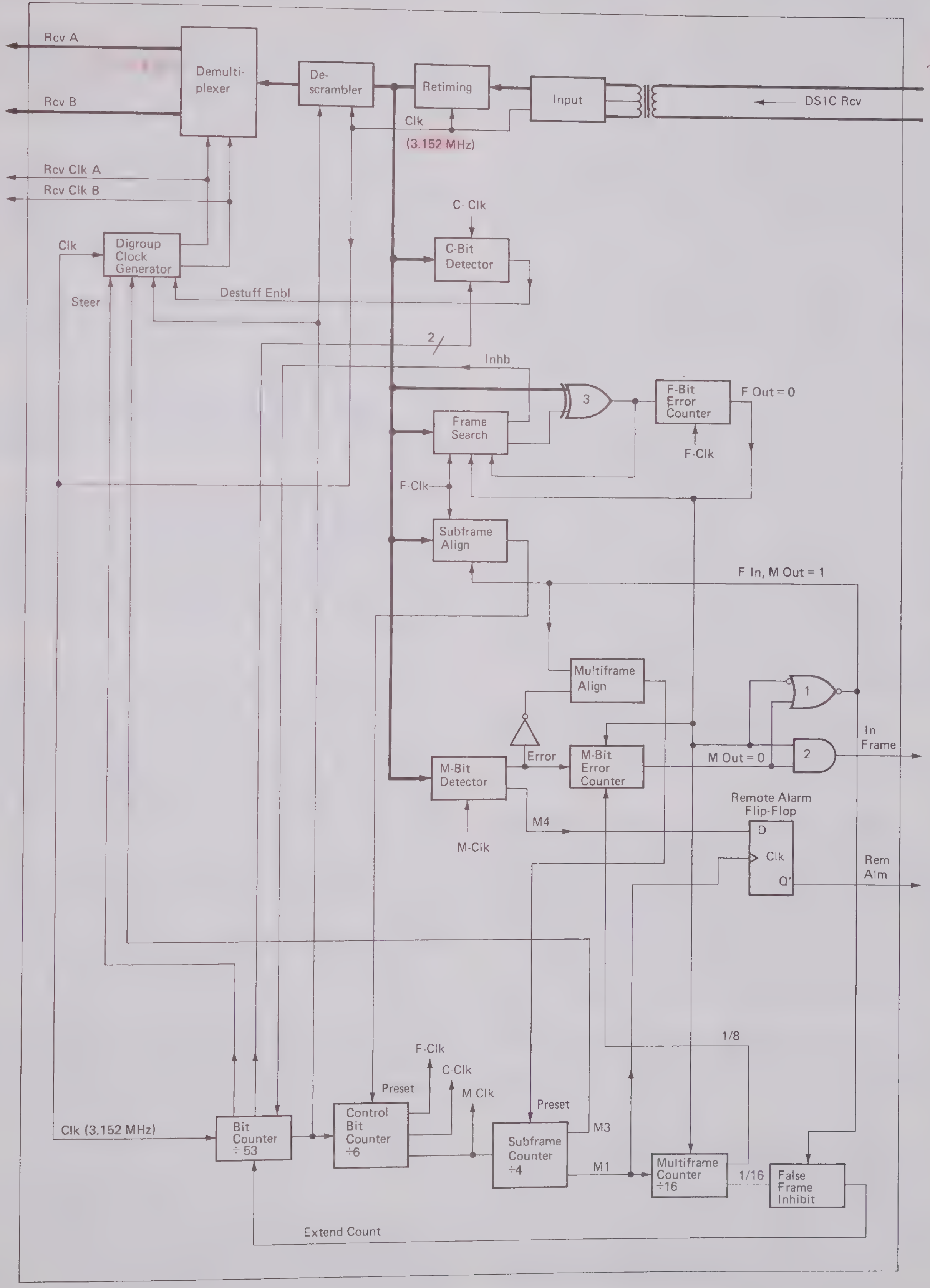

(J15)
Xmt A 18
Xmt B 24
Xmt Clk 16
J1
P51
10
4
6
Transmit Section, Figure A
P51
J1
8
7
9
5
3
1
Rem Alm
+5V
K1
45 Ω
20 dB Pad
15 dB Pad
(J15)
4
2
DS1C Xmt
42
40
DS1C Rcv
28
Xmt Intlk
7
LP'
33
LP Req'
17
AC1 A
36
AC1 B
Rcv A 39
Rcv B 37
Rcv Clk A 34
Rcv Clk B 38
Receive Section Figure B
In-Frame
200 ms Delay
LOCAL
Red
+5V
Rem Alm
1
REMOTE
Yel
Q1
+5V
−12V 1
−12V
+5V 31 32
+5V
Bat Gnd 29 30
TEST
FAIL
Red
2
Logic
+5V
PASS
Grn
3
Figure A. Transmit Section
(J1)
P51
Xmt A 10
Xmt B 4
Dual Elastic Store
Digroup Combiner
Clk
(3.152 MHz)
Scrambler
Control Bit Insertion
Re-timing
Bipolar Converter
+5V
P51
(J1)
8
7
DS1C Xmt
Control Bit Selector
F1
Cc
Cb
F0
Ca
M
+5V
M-Bit Generator
4
9
Rem Alm
Read
Write
5
Xmt Intlk
Clk
Xmt Clk (1.544 MHz) 6
Write Counter
3
Address Comparator
Stuff Control
+5V
3
+5V
1
Gnd
Read Counter
3
48 50 52 2
49 51 1 3
1.576 MHz with gaps
3
2
3.152-MHz Clock
Bit Counter ÷53
Control Bit Counter ÷6
Subframe Counter ÷4
Clk
087-56942-01

Figure 3-20. 91426 Syndes Unit, Circuit Diagram (Sheet 2 of 2)

Figure B. Receive Section


Rcv A
Rcv B
Demulti-plexer
De-scrambler
Retiming
Input
DS1C Rcv
Clk
(3.152 MHz)
Rcv Clk A
Rcv Clk B
C- Clk
Clk
Digroup Clock Generator
C-Bit Detector
Steer
Destuff Enbl
2
Inhb
3
F-Bit Error Counter
F Out = 0
Frame Search
F-Clk
F-Clk
Subframe Align
F In, M Out = 1
Multiframe Align
1
Error
M-Bit Error Counter
M Out = 0
2
In Frame
M-Bit Detector
Remote Alarm Flip-Flop
D
M4
Clk
M-Clk
Q'
Rem Alm
1/8
F-Clk
C-Clk
Preset
M Clk
Preset
Clk (3.152 MHz)
Bit Counter ÷53
Control Bit Counter ÷6
Subframe Counter ÷4
M3
M1
Multiframe Counter ÷16
1/16
False Frame Inhibit
Extend Count

(Continued from page 43.)

counters with the incoming data by one bit. This process is repeated until there is a correct comparison or until all eight bits have been tested. Then, the search moves to the next F-bit time slot location.

3.163 If a correct comparison is not found in the first bit, an error pulse is output. The F-bit error counter tallies the pulses and resets at the end of each multiframe. When a multiframe has no errors, the counter output goes low as an in-frame indication.

3.164 Subframe Align. The subframe align circuit monitors the F-bit time slots and, at each F1 bit, outputs a presetting pulse that aligns the control bit counter with the subframe. This circuit is active only during the reframing process when F frame alignment has been established but M is still out-of-frame.

3.165 M-Bit Detector. The M-bit detector is essentially a shift register in which the last four M-bits received are stored. Bits M1, M2, and M3 are decoded during the Ca to F0 interval of subframe M3 and an error pulse is output if the pattern is not 011. Bit M4 is output separately to the remote alarm detector.

3.166 M-Bit Error Counter. This circuit counts error pulses from the M-bit detector and resets every eight multiframes. If the error count reaches three, the output goes low as an out-of-frame indication. Once M is out-of-frame, an error-free interval of eight multiframes is required to return to an in-frame condition.

3.167 When F is out-of-frame, the M-bit error counter output is forced low to the out-of-frame condition.

3.168 Mulitframe Align. If F is in-frame and M is out-of-frame, when the M-bit detector output goes low in response to the correct M-bit pattern (011) in the receive signal, the multiframe align circuit presets the subframe counter to M3 and thus aligns it with the receive data multiframe.

3.169 Remote Alarm Flip-Flop. Control bit M4 from the receive signal is sampled by the remote alarm flip-flop during each M1 subframe. If M4 is 0 (alarm condition), the Rem Alm lead goes high.

3.170 False Frame Inhibit. The false frame inhibit circuit is clocked every 16 multiframes by the multiframe counter. If F is in-frame and M is out-of-frame when the circuit is clocked, the bit counter is extended one count during the Cb to Cc interval. This reinitiates the search for the alternating F-bit pattern to prevent false framing on a signal that has a repetitive 1/0 pattern in the data bits but does not have the correct M-bit pattern.

91420 Alarm Control Unit

3.171 The alarm control unit (figure 3-21) monitors these conditions in the channel bank:

(a) Frame synchronization via the AC1 lead from the receive unit.

(b) System alarm status at the remote channel bank via the AC2′ lead from the receive unit.

(c) Output voltages of the 91425 Power Supply Unit via the Pwr Alm lead.

(d) Integrity of the PS, SIG, and TALK fuses on the 91400 shelf and the 20 Hz fuse on the 91424 Battery Filter Unit via the FA′ lead.

3.172 In modes 2 and 3, each of the two alarm control units monitors AC1, AC2′, and FA′ of the associated digroup; both units monitor Pwr Alm. The interunit alarm circuit wiring is on figure 3-2.

3.173 In mode 1, the one alarm control unit is installed in the unit A position (J14) and monitors AC1, AC2′, Pwr Alm, and both FA′ leads. Although AC1 and AC2′ from the receive unit are designated for digroup A, they actually represent the conditions in digroup B; digroup A is not monitored.

3.174 Microcomputer U1 (paragraph 3.202) continuously samples the inputs described above and generates control signals and timing signals appropriate for the normal or alarm condition. If an alarm condition occurs, the SA (system alarm) relay is released to activate the office alarm circuits. The SYS ALM lamp lights and, if applicable, the LOC (local) or REM (remote) indicator lights.

3.175 When the channel bank is in system alarm, a loop test mode can be set up by the LOOP or TMB HOLD pushbutton. Again, microcomputer U1 performs the necessary logic and timing functions.

3.176 Figure 3-22 is the alarm control unit timing diagram. Controls and indicators and input and output signals are described in paragraphs that follow and are summarized in figure 3-23.

3.177 System Alarm. The normally-operated SA relay, controlled from output port P17 of U1, is released by a power alarm or fuse alarm immediately, by a local alarm after a 2.5-second delay, or by a remote alarm after a 450-ms delay.

3.178 With the SA relay released and the ACO (alarm cutoff) relay operated, the system alarm is maintained by operation of the TMB HOLD or LOOP pushbutton.

3.179 When the SA relay releases, a 10-second software delay in U1 is started and must time out, even if the alarm conditions clear. Thereafter, if the system alarm is being maintained by a remote alarm or by the TMB HOLD pushbutton, the SA relay operates immediately when these conditions clear. If the system alarm is being maintained by a local alarm, power alarm, fuse alarm, or LOOP pushbutton, the SA relay waits an additional 5 seconds after these conditions clear before it operates.

3.180 External Alarms. Three form C contacts on the SA relay are available to control external audible, visual, and EAX alarms. With the SA relay released, momentarily depressing the ACO pushbutton latches up the ACO relay, restoring the audible alarm circuit to normal. The visual alarm circuit is also restored if the A/B strapping plug is in position A. When the SA relay operates, the ACO relay releases automatically.

3.181 Local Alarm. The AC1 lead from the receive unit is monitored by microcomputer U1 at input port P06, and samples at 5-ms intervals are integrated in software on the basis that out-of-frame = +2 counts and in-frame = −1. If the count reaches 24, corresponding to continuously out-of-frame for 60 ms, the LOC indicator is turned on from output port P11. The REM indicator is locked out by the software.

3.182 The +2/−1 integration of AC1 samples continues, but only between the upper threshold of 24 and 0. If the count reaches 0 in less than 2.5 seconds, the local alarm clears. (See timing diagram, figure 3-22.) Otherwise, a system alarm begins. After 10 seconds or when the count reaches 0 and clears the local alarm, whichever occurs later, a 5-second delay is started. After 5 seconds, the system alarm clears.

3.183 In another software integration of AC1 samples, out-of-frame = +8 counts and in-frame = −1. If this count reaches 4096 (2.56 seconds out-of-frame), a local alarm is initiated and the following actions take place:

(a) Output port P17 of U1 goes to logic 1, releasing the SA relay. Contacts of the relay light the SYS ALM lamp and activate external alarms and the TMB1′ (trunk-make-busy) lead to the channel units.

(b) AC6′ goes to logic 0, inhibiting channel signaling bits in the receive unit.

(c) The +8/−1 integration counter is reset and will not be enabled until the system alarm clears.

3.184 Remote Alarm. At the near channel bank, if bit 2 of a channel word in the incoming pcm signal is binary 1, the receive unit outputs a positive logic pulse on AC2′. Thus, the normal AC2′ signal is random pulses. (Bit 2 occurs every 5.07 or 5.18 μs, the length of a channel word.)

3.185 If the far channel bank goes into system alarm because of a local alarm, power alarm, or fuse alarm, the alarm control unit there activates AC4. This is done under software control through output port P15 of U1. In the transmit unit, AC4 forces bit 2 of all channel words to binary 0 ("bit 2 suppression").

3.186 At the near channel bank, the AC2′ signal from the receive unit becomes steady logic 0. After a 410-ms hardware delay, input port P01 of U1 goes to logic 0. If it remains so for at least 40 ms, under software control U1 lights the REM indicator through output port P10 and sets AC3′ to logic 0 through output port P16. The function of AC3 (inverted AC3′) is to mute the vf bits of channel words in the receive unit.

3.187 When AC2′ returns to normal, AC3 becomes logic 0 after 30 ms and the REM indicator goes dark after an additional 70 ms.

3.188 Simultaneous Remote and Local Alarms. As described previously, the REM indicator is locked out by lighting of the LOC indicator. But in the following special situation, REM and LOC can be on simultaneously. Assume a local alarm at the near channel bank and a consequent remote alarm at the far bank. If the near bank is looped for troubleshooting, it sends out an all-1's signal, which at the far bank initiates remote alarm time-out and local alarm time-in. This happens because the all-1's signal has bit 2's = 1 but does not contain framing information.

3.189 From the timing diagram, figure 3-22, it seems that the system alarm at the far bank would time-out (30 ms) before the LOC indicator came on (60 ms). However, the local alarm timing has a 20-ms threshold at which an existing system alarm is maintained. Without the 20-ms threshold, REM would go dark and LOC would light. Instead, both indicators are lighted. Thus, important troubleshooting information is not lost at the far end because of a procedure at the near end.

3.190 Trunk Make Busy. The alarm control unit supplies two trunk-make-busy signals (TMB1′ and TMB2′) and a timing signal (TP′) to the channel units. One signal (TMB1′) is controlled by the SA relay and the other two are generated by U1 under software control.

3.191 As shown on the timing diagram, figure 3-22, in normal operation TMB1′ and TMB2′ are steady logic 1 and TP′ is a 50-ms logic 0 pulse every 12.5 seconds. At the onset of a system alarm, TMB1′ is grounded by release of the SA relay. Following a 2-second delay, TP′ goes to logic 0 for 50 ms, after which TMB2′ goes to steady logic 0.

3.192 The function of the single 50-ms TP′ pulse is to "wink" certain dial pulse originating (DPO) channel units to an idle state, thereby dropping subscriber connnections. After the pulse, the channel units return to the busy state for the alarm duration.

3.193 The TP′, TMB1′, and TMB2′ buses from alarm control units A and B are wired to the channel units of digroups A and B, respectively. See figure 3-2B. The bus configurations are affected by the position of the Y/Z strapping plug and by switching contacts on receptacle connectors J14 and J29 as follows:

(a) In channel bank mode 1, which does not use alarm control unit B, corresponding A and B buses are connected together.

(b) In mode 1, removal of unit A grounds the TMB1′ and TMB2′ buses.

(c) In mode 2 or 3, removal of unit A or B grounds the TMB1′ and TMB2′ buses of the associated digroup.

(d) In mode 2 or 3, removal of unit B connects the A and B TP′ buses together.

3.194 Looped Line (LL) Status. With the SA relay released and the ACO relay operated, depressing the TMB HOLD pushbutton lights the TMB HOLD indicator and produces logic 1 at input port P05 of U1. Through software, the system alarm is held and the REM indicator lockout feature is disabled. Also, AC4 is activated through output port P15, causing the transmit unit to suppress bit 2 in the outgoing pcm channel words.

3.195 This channel bank status is useful in isolating trouble caused by intermittent or marginal signal conditions on the repeatered line. If the digital line signal is looped back at a repeater, the REM indicator lights if the line out and back is good and the LOC indicator lights if it is bad. (REM lights because bit 2 is suppressed in the signal sent out and returned.)

3.196 Looped Terminal (LT) Status. With the SA relay released and the ACO relay operated, depressing the LOOP pushbutton lights the LOOP indicator and grounds the AC5′ lead to the transmit unit and receive unit. The pcm signal from the transmit unit is switched to the receive unit input and an all-1's signal is sent to the line.

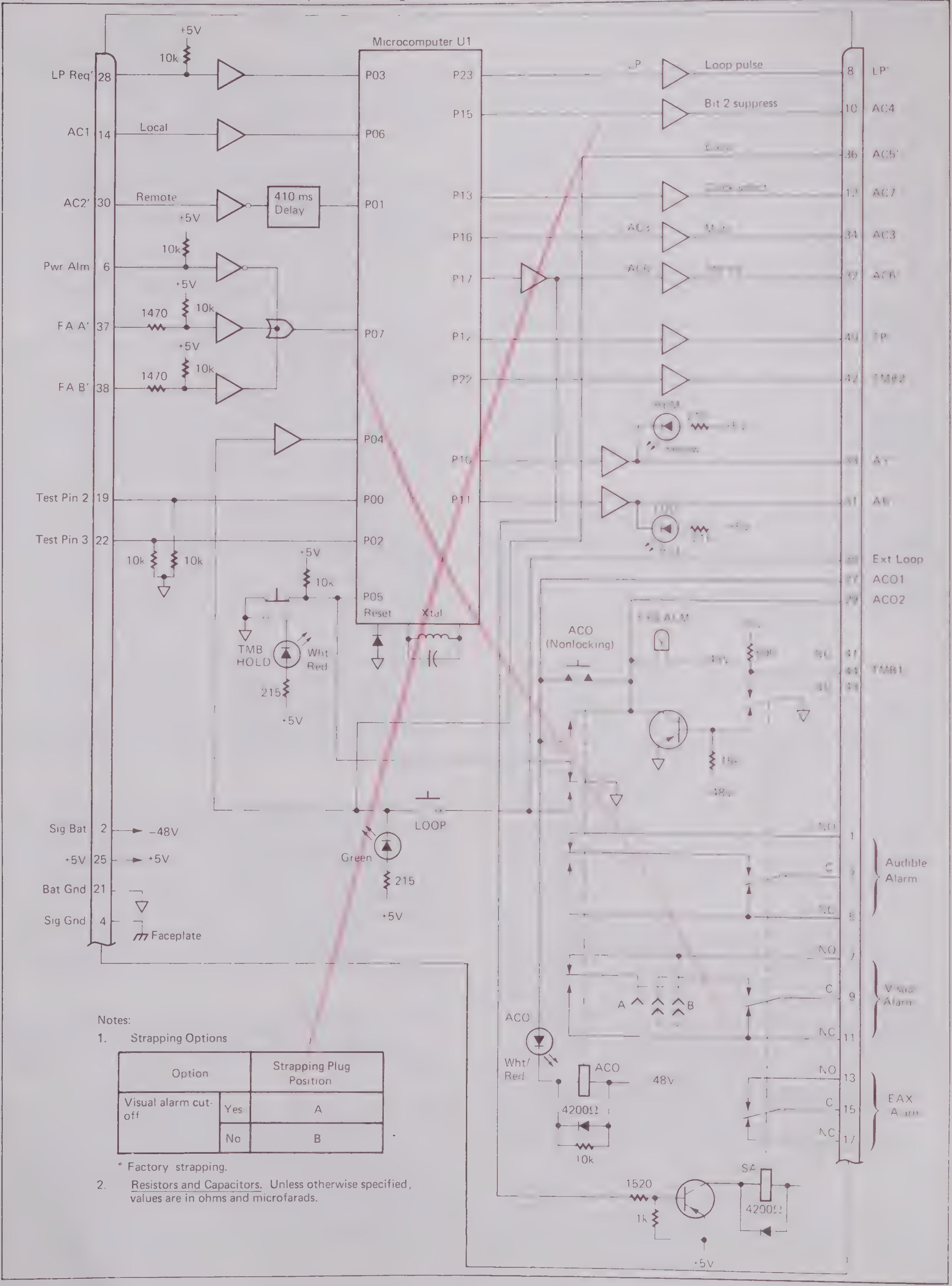
3.197 The logic 0 (ground) from the LOOP pushbutton also is applied to input port P04 of U1. Software prevents the system alarm from clearing until the LOOP pushbutton is released.

3.198 The LT status can be controlled remotely by a circuit closure between the Ext Loop and the AC5′ leads, which are wired to the 91448 Office Interface Unit connector J30.

3.199 Looped Receive Clock. With an active signal at input port P06 (AC1, out-of-frame), P04 (LT status), or P05 (LL status) of microcomputer U1, AC7 is activated through output port P13. If the transmit unit is strapped for looped receive clock operation, AC7 causes a switch to internal clock (or Rcv Clk B in some mode 2 or mode 3 conditions) as the transmit clock source. When the input ports are clear, U1 clears AC7 after a 5- to 15-second delay.

(Text continues on page 51.)

Figure 3-21. 91420 Alarm Control Unit, Circuit Diagram


Microcomputer U1
LP Req' 28
AC1 14
AC2' 30
Pwr Alm 6
FA A' 37
FA B' 38
Test Pin 2 19
Test Pin 3 22
Sig Bat 2
+5V 25
Bat Gnd 21
Sig Gnd 4
Faceplate
-48V
+5V
10k
1470
Local
Remote
410 ms Delay
P03
P06
P01
P07
P04
P00
P02
P05
Reset
Xtal
P23
P15
P13
P16
P17
P12
P22
P10
P11
TMB HOLD
Wht Red
215
Green
LOOP
Loop pulse
Bit 2 suppress
8 LP'
10 AC4
36 AC5'
AC7
34 AC3
AC6'
TP
TMB2
AT
AR
Ext Loop
ACO1
ACO2
ACO (Nonlocking)
TMB1
NO
C
NC
1
5
7
9
11
13
15
17
Audible Alarm
Visual Alarm
EAX Alarm
A
B
ACO
Wht/ Red
4200Ω
10k
48V
1520
1k
SA
+5V

Notes:

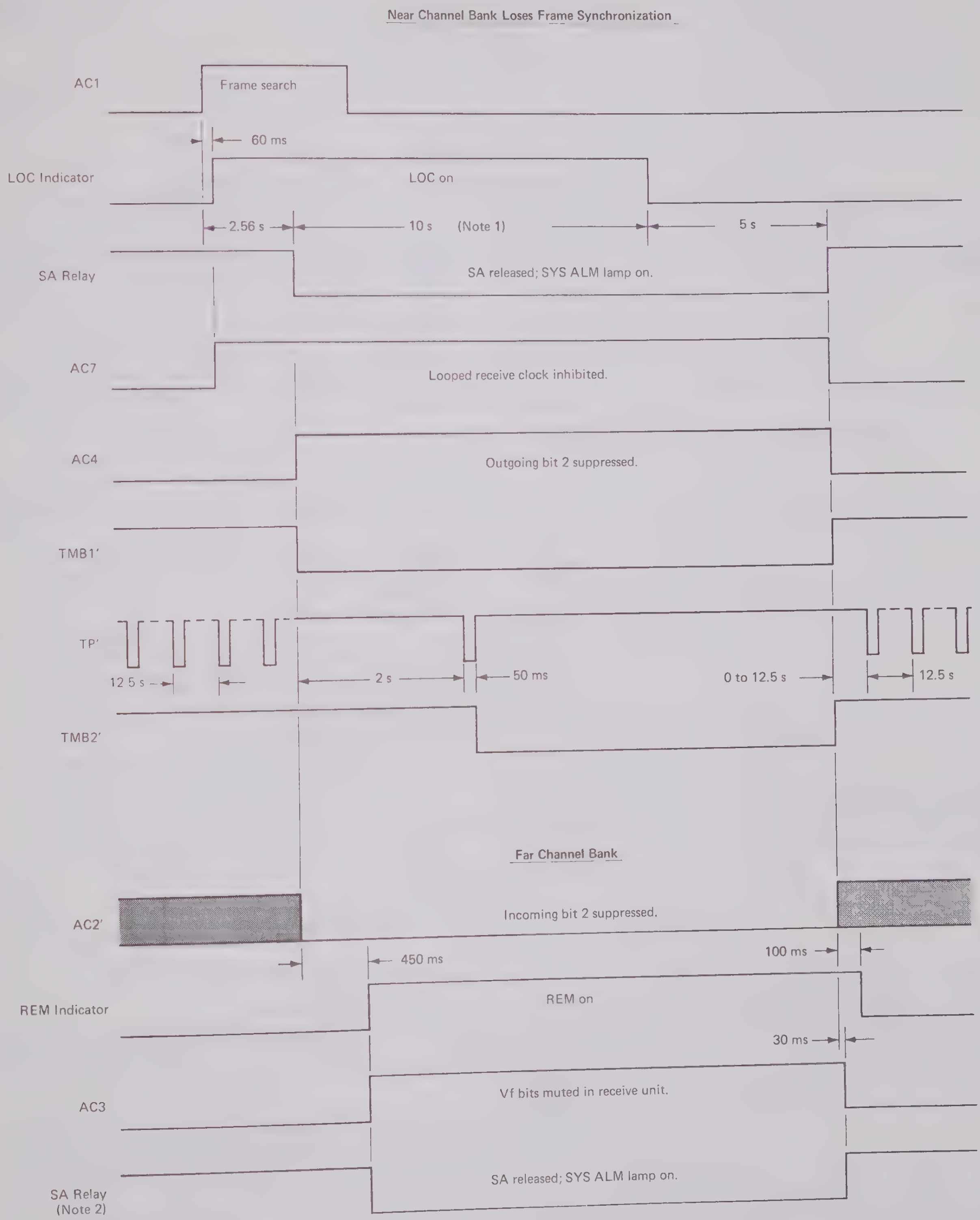
1. Strapping Options

Option		Strapping Plug Position
Visual alarm cut-off	Yes	A
	No	B

* Factory strapping.

2. Resistors and Capacitors. Unless otherwise specified, values are in ohms and microfarads.

Figure 3-22. 91420 Alarm Control Unit Timing Diagram


Near Channel Bank Loses Frame Synchronization
AC1
Frame search
60 ms
LOC Indicator
LOC on
2.56 s
10 s (Note 1)
5 s
SA Relay
SA released; SYS ALM lamp on.
AC7
Looped receive clock inhibited.
AC4
Outgoing bit 2 suppressed.
TMB1′
TP′
12 5 s
2 s
50 ms
0 to 12.5 s
12.5 s
TMB2′
Far Channel Bank
AC2′
Incoming bit 2 suppressed.
450 ms
100 ms
REM Indicator
REM on
30 ms
AC3
Vf bits muted in receive unit.
SA Relay (Note 2)
SA released; SYS ALM lamp on.

Notes:

1. Local Alarm. If the LOC indicator is still lighted at the end of the 10-second delay, the delay is extended until the +2/−1 integration of AC1 samples reaches a count of 0 (in-frame continuously for 120 ms).
2. Far Channel Bank. TMB1′, TP′, and TMB2′ at the far channel bank follow the SA relay as shown for the near channel bank.

Figure 3-23. 91420 Alarm Control Unit; Inputs, Outputs, Controls, and Indicators (Sheet 1 of 2)

	Name	Description
Inputs	AC1	Local alarm; indicates frame synchronization. Normal (in-frame) = logic 0 Alarm (out-of-frame) = logic 1
	AC2'	Remote alarm; indicates status of bit 2 in the incoming channel words. Normal = random logic 1 pulses Alarm = steady logic 0
	FA-A' and FA-B'	Fuse alarm; indicates condition of PS, SIG, and TALK fuses on shelf and 20 Hz fuse on 91424 unit. Normal = 2.4V Alarm (blown fuse) = 0.4V
	Pwr Alm	Power alarm; indicates status of 91425 Power Supply Unit. Normal = 0.4V Alarm = 2.4V
	LP Req'	Loop pulse request; grounded when TEST pushbutton on 91426 Syndes Unit is depressed.
Outputs	AC3	Mutes vf bits of channel words in the receive unit during a remote alarm. Normal = logic 0 Alarm = logic 1
	AC4	Suppresses bit 2 of channel words in the transmit unit during a local alarm or in looped line (LL) status. Normal = logic 0 Alarm = logic 1
	AC5'	Loop control; with SA relay released and ACO relay operated, depressing LOOP pushbutton grounds AC5'.
	AC6'	In the receive unit, forces signaling bits of channel words to idle during system alarm. Normal = logic 1 Alarm = logic 0
	AC7	Switches transmit unit from looped Rcv Clk A to Rcv Clk B or Int Clk; activated to logic 1 in a local alarm, looped terminal (LT) status, or looped line (LL) status; restores when system alarm clears.
	LP'	In LT status, activated from open to logic 0 for 300 ms by operation of TEST pushbutton on syndes unit; loops DS1C signal and unloops digroup signal(s).
	TMB1'	Trunk-make-busy signal to channel units. Normal = logic 1 (500-ohm pullup) System alarm = ground
	TMB2'	Trunk-make-busy signal to channel units. Normal = open System alarm = logic 0 after end of single TP' pulse
	TP'	Timing pulses (logic 0 for 50 ms) to channel units. Normal = a pulse every 12.5 seconds System alarm = single pulse 2 seconds after alarm begins.
Inputs from 91448 unit (future)	ACO1 and ACO2	Closure between these leads is equivalent to operating the ACO pushbutton.
	Ext Loop	Closure between Ext Loop and AC5' is equivalent to operating the LOOP pushbutton.
Outputs to 91448 unit (future)	AR'	Local alarm indication. Normal = logic 1 Alarm = logic 0
	AY'	Remote alarm indication. Normal = logic 1 Alarm = logic 0
Outputs to office	Audible alarm	Form C contacts on normally-energized SA relay; alarm is restored by operation of ACO relay.
	Visual alarm	Form C contacts on normally-energized SA relay; as a strapping option, alarm can be restored by operation of ACO relay.
	EAX alarm	Form C contacts on normally-energized SA relay.
Control and indicators	LOOP	Locking pushbutton and green LED. If the SYS ALM lamp and ACO indicator are lighted, depressing the LOOP pushbutton does the following: lights the LOOP indicator; loops the 48-channel (mode 1) or 24-channel (mode 2 or 3) digital signal from the transmit unit to the receive unit; transmits an all-1's signal to the digital line.
	ACO	Nonlocking pushbutton and white-red LED. If the SYS ALM lamp is lighted, depressing the ACO pushbutton operates the alarm cutoff relay and lights the ACO indicator. Relay operation disables the audible alarm and visual alarm (strapping option) circuits to the office but does not affect the EAX alarm circuit. The alarm cutoff relay releases automatically when the system alarm condition clears.
	LOC	Red LED. Indicates loss of receive signal or an out-of-frame condition. LOC has a 40-ms integration time, whereas FR SCH on the receive unit is instantaneous.
	REM	Yellow LED. Indicates the remote channel bank is in a system alarm condition initiated by a local alarm or maintained by an operated TMB HOLD pushbutton.

Figure 3-23. 91420 Alarm Control Unit; Inputs, Outputs, Controls, and Indicators (Sheet 2 of 2)

	Name	Description
Control and Indicators (Cont.)	TMB HOLD	Locking pushbutton and white-red LED. With the SYS ALM lamp and ACO indicator lighted, depressing the TMB HOLD pushbutton forces bit 2 of the transmit channel words to 0 and maintains the system alarm condition. The TMB HOLD indicator lights while the pushbutton is depressed. If the digital line signal is looped back, REM lights if the signal is received and framed upon; otherwise LOC lights.
	SYS ALM	Yellow lamp. Indicates a system alarm condition, which is initiated by a power, local, or remote alarm. With the alarm cutoff relay operated, a system alarm is maintained by an operated LOOP or TMB HOLD pushbutton.

3.200 Loop Pulse. Operation of the TEST pushbutton on the 91426 Syndes Unit grounds the LP Req′ line, which is monitored by U1 at input port P03. If the digroup is in LT status, U1 generates a 300-ms logic 0 pulse on the LP′ line via output port P23. In the syndes unit, the LP′ pulse momentarily energizes a relay to loop the DS1C signal, transmit to receive.

3.201 In the mode 2 transmit unit, the LP′ pulse and AC5′ are logically combined to produce a winked AC5′ signal (WAC5′). This signal is used in the mode 2 transmit unit and the mode 2 receive unit to momentarily unloop the DS1 signal of the applicable digroup.

3.202 The software performs a debouncing function for the TEST pushbutton and requires that the LP Req′ line be normal for 50 ms after one LP′ pulse ends before another can be generated.

3.203 Test Pins. Input ports P00 and P02 of U1 are used in factory testing. For normal operation of the alarm control unit, these ports are grounded on the 91400 shelf.

3.204 Reset. The reset input of U1 is connected to ground through a diode. If the +5V supply drops 1.5 volts or more and then recovers rapidly, the microcomputer program is reset to the initialized state. This protects against operation with faulty data resulting from a supply voltage transient.

Microcomputer in the 91420 Alarm Control Unit

3.205 Nearly all logic and timing functions of the alarm control unit are performed by microcomputer U1, which appears on figure 3-21. The microcomputer is a single-chip device with the following characteristics as used in the 91420 application.

(a) Eight-bit central processor unit (CPU)

(b) Mask-programmed ROM (program memory): 1K × 8 bits

(c) Dynamic RAM (data memory): 64 × 8 bits

(d) Input ports: 8 lines of port P0

(e) Output ports: 9 lines of ports P1 and P2

(f) Internal clock: 3 MHz; frequency is controlled by an external coil and capacitor connected to the Xtal input

(g) Instruction execution time: 10 or 20 μs

(h) Internal hardware timer: 82-ms period

3.206 Instructions. The microcomputer operates in a continuous series of instruction cycles. In each cycle, the applicable instruction is fetched from program memory and the operation specified by the instruction is performed. The main program is a continuous loop of more than 350 instructions; a complete loop is executed every 5 milliseconds.

3.207 Instructions fall into one of the following general categories: arithmetic, logic, input/output, internal data move, and conditional branch. In the software documentation, each instruction is identified by a shorthand notation called a "mnemonic code." Three typical instructions and their mnemonic codes are described below:

Mnemonic	Instruction
IN A,P0	Read the data at input port P0 into accumulator A (a register in the CPU).
OUTL P1,A	Write the data in accumulator A to output port P1.
ORL A,R2	Logically OR each bit in accumulator A with the corresponding bit in register R2. Store the results in accumulator A.

3.208 Flags. Selected conditions that occur during program operation are stored as "flag" bits in one of three registers in RAM. For example, bit 2 of register R3 represents the status of the LOC indicator; binary 0 is normal and binary 1 is alarm.

3.209 I/O Ports. On the 91420 unit, P0 of microcomputer U1 is the input port and its eight lines are designated P00 through P07. The output ports are P1 and P2, but not all lines are used. Ports P10 and P11 are high-drive outputs capable of sinking 7 mA.

3.210 Data written to an output port is statically latched and remains intact until changed by another output instruction. Input ports are nonlatching; that is, data must be present until read by an input instruction.

91442 VF Test Set

3.211 The 91442 VF Test Set (figure 3-24) has two independent sections, L on the left and R on the right, and a common center section. In end-to-end channel performance tests, the TEST receptacle connector on the channel unit is patched to the CHANNEL UNIT receptacle connector in Section L or Section R, as specified in the test procedure. In loop tests, one channel unit is patched to Section L and the other to Section R. Patching is done with 12-conductor 796A Patch Cords.

3.212 The XMT-RCV toggle switch (S9) in the center section has two positions: L-R and R-L. In position L-R, an analog test-tone from the internal oscillator, or an external oscillator, is routed to the transmit input of the channel unit patched to Section L. The receive output of the channel unit patched to Section R goes to the LEVEL, DISTN, and CRSTLK jacks. An external meter is connected to the applicable jack as specified in the test procedure. The internal test set circuits include a 1020-Hz band elimination filter at the DISTN jack and a 1020-Hz bandpass filter at the CRSTLK jack.

3.213 By setting switch S9 to position R-L, the direction of transmission described above is reversed. That is, the test-tone goes to the transmit input of the channel unit patched to Section R, and the receive output of the channel unit patched to Section L goes to the external meter. The L-R and R-L configurations are set up through contacts of XMT-RCV switch S9 and relays K1 and K2, one of which is operated in each switch position.

3.214 Subassemblies. The test set includes subassemblies A1 through A4 and A6. A1 and A3 are identical receive circuit boards. A2 and A4 are identical transmit circuit boards. A6 contains the 1020-Hz bandpass filter and the 1020-Hz band elimination filter. All these subassemblies are mounted on main circuit board A5. Although A1 through A4 are plug-in boards, they are factory-calibrated and should not be interchanged or replaced in the field.

3.215 VF Interface. Sections L and R each have three mechanically-interlocked VF INTFC pushbutton switches: 2W 600Ω, 2W 900Ω, and 4W 600Ω. Depressing the pushbutton applicable to the channel unit under test sets up a two-wire or four-wire interface and coordinates test set levels and impedances with the channel unit.

3.216 The transmit amplifier on A2 and A4 has three feedback paths for setting gain, one for each vf interface. The feedback paths include the factory-calibration potentiometers. Amplifier output impedance is built out by series resistors and capacitors, which also serve as terminations at the receive amplifier input.

3.217 Levels. The transmit and receive attenuators are switch selectable in 0.1-dB steps betweeen 0 and 6.3 dB. With these attenuators set at the same values as the strappable attenuators on the channel unit under test, the normal receive level indication on an external meter is 0 dBm. This applies to a two-wire channel unit or to a four-wire channel unit with tandem attenuators strapped for 0 dB loss.

3.218 The dB values marked adjacent to the XMT ATTEN and RCV ATTEN switches actually indicate decrease in loss from 6.3 dB, rather than loss. With all six switches in the 0 dB position, the attenuator loss is 6.3 dB. If the 0.4 dB switch, for example, is then set at 0.4 dB, the loss becomes 5.9 dB. However, in using the test set, it is only necessary to set the switches to agree with the channel unit strapping, without being concerned about the effect on gain or loss.

3.219 For four-wire and two-wire channel units, respectively, the nominal receive levels at the TEST connector are +7 and −3 dBm and the test set receive attenuator switch settings are 1.5 and 3 dB. (As explained in the preceding paragraph, the loss in the test set attenuator is 6.3 dB minus the switch settings; hence, the losses are 4.8 and 3.3 dB for four-wire and two-wire channel units, respectively.) To compensate for the differences in receive levels (10 dB) and receive attenuator losses (1.5 dB), an 8.5 dB pad is inserted in the measuring circuit when the 4W 600Ω pushbutton is depressed.

3.220 In measuring channel distortion, a meter reading is made at each of the five positions of the SEND LEVEL switch, thereby checking linearity of the channel unit codec. For all other test procedures, the switch is set at 0 dB.

3.221 E&M Channel Units. Pins 7-8 of the TEST connector on an E&M channel unit are assigned to the E lead. Inserting a cord in the T1-R1 CARR jack for vf testing grounds the E lead, but the ground is lifted when a cord is inserted in the E&M CARR jack for pulsing tests.

3.222 Power. Office battery is patched to the −48V IN jack and is available at the −48V OUT jack for other test equipment. The POWER indicator lights through relay K1 or K2 according to the setting of XMT-RCV switch S9. Maximum current drain of the test set itself is 70 mA.

91443 Test Patch Panel

3.223 In channel performance tests with a 91232 Test and Alignment Set, the CHANNEL UNIT connector on the 91443 panel (figure 3-25) is patched to the TEST connector on the channel unit with a 12-conductor 796A Patch Cord. The vf and E&M signaling leads can then be accessed toward the drop or carrier at miniature tip-ring sleeve jacks on the 91443 panel.

3.224 The left side of the panel has two identical sets of jacks. This enables two channel units to be accessed at the same time for loopback testing. As an option code (figure 5-4), the right side of the panel can be equipped with a 24-position jack block, with or without miniature tip-ring-sleeve jacks.

91444 Test Shelf

3.225 The 91444 shelf has a pair of channel units and a spare set of common equipment operating in loopback mode. The condition of a unit removed from a working channel bank can be verified by substituting it in the test shelf.

3.226 The shelf also includes a 91447 Selector Unit, by means of which the channel unit pair can be allocated to any channel time slot of either digroup. Also, a 91446 Signaling/Interface Unit has controls and indicators for exercising either loop or E&M signaling.

3.227 For complete information on the 91444 Test Shelf, refer to GTEP Section 342-911-125.

91445 Signaling Path Test Set

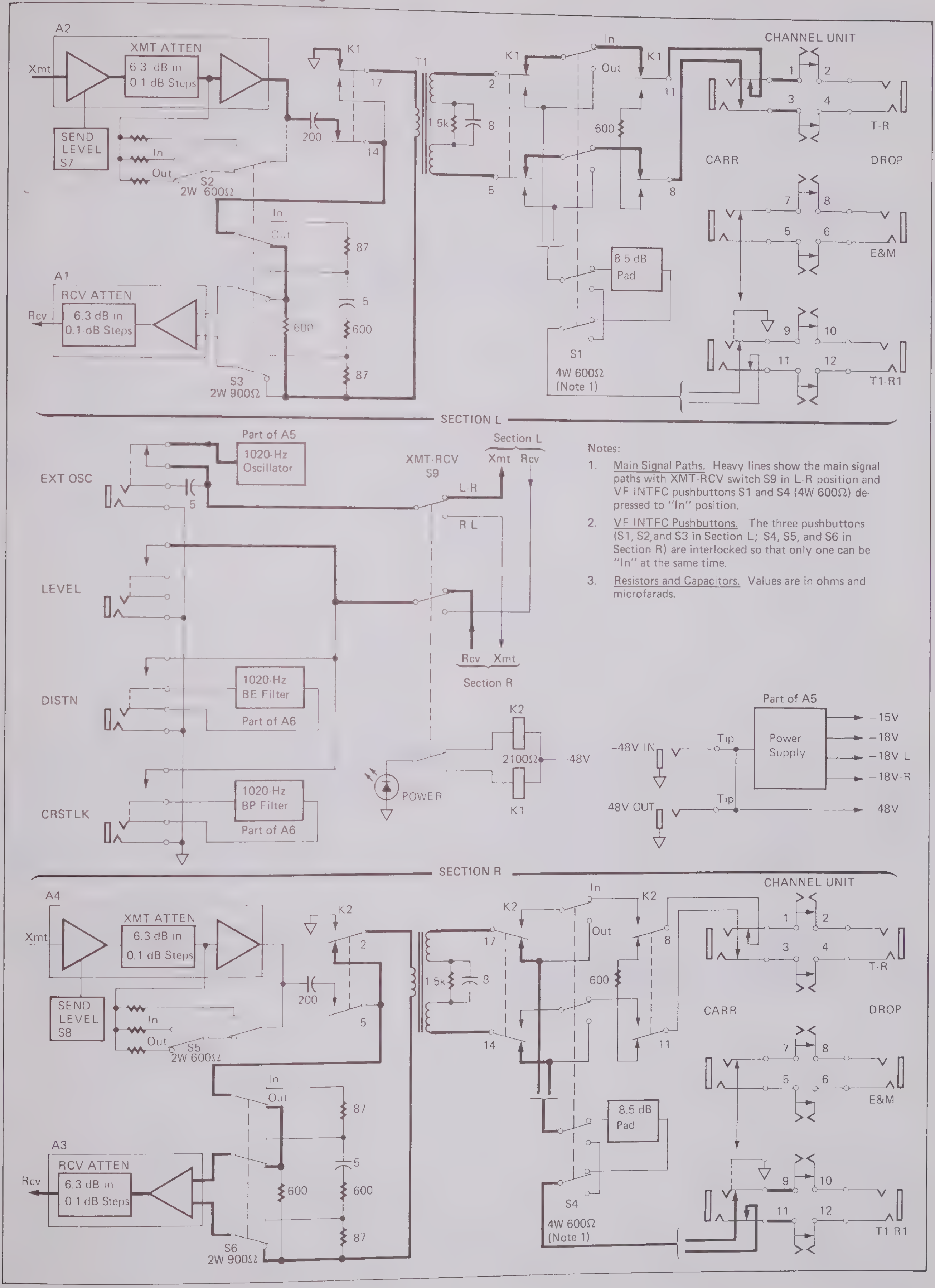
3.228 The vf transmission and signaling/supervision (but not pulsing) over the system on any channel can be checked by replacing the channel unit at one or both banks with a 91445 Signaling Path Test Set. The test set (figure 3-26), which plugs into the vacated channel unit mounting slot, has a TEST receptacle connector for vf access through a 91442 VF Test Set or a 91443 Test Patch Panel. It also has two toggle switches and two LED indicators for controlling and monitoring the A and B signaling channels.

3.229 VF Transmission. At the TEST connector, the test set has a balanced, four-wire 600-ohm vf interface at −16 TLP transmit and +7 TLP receive. The usual tandem attenuators of a four-wire channel unit are omitted and the 6.3-dB step attenuators are replaced by 1.5-dB pads. Consequently, when the 91442 test set is used with the 91445 test set, the attenuator switches on the 91442 should be set at 1.5 dB.

3.230 Transmit Signaling. Switches S2 and S1 control the A and B signaling channels, respectively. During frames 6 through 11, transmit signaling pulse SigEnBT disables gate 2 and the inverted pulse enables gate 1. The setting of switch S2 appears on Sig-x as logic 1 for XMT-A and logic 0 for IDLE, and is transmitted as bit 8 of the channel word in frame 6.

3.231 In a similar manner, the setting of switch S1 is transmitted on the B signaling channel in frame 12. As explained in a previous discussion of channel unit timing, the coder recognizes signaling frames 6 and 12 from the width of channel pulse ChPT-(n)′.

Figure 3-24. 91442 VF Test Set, Circuit Diagram


A2
XMT ATTEN
Xmt
6.3 dB in
0.1 dB Steps
SEND LEVEL S7
In
Out
S2
2W 600Ω
K1
T1
200
17
14
2
5
1.5k
8
In
Out
600
11
8
CHANNEL UNIT
1
2
3
4
T-R
CARR
DROP
7
8
5
6
E&M
87
5
600
600
87
A1
RCV ATTEN
Rcv
6.3 dB in
0.1 dB Steps
S3
2W 900Ω
8.5 dB Pad
S1
4W 600Ω
(Note 1)
9
10
11
12
T1-R1
SECTION L
Part of A5
1020-Hz Oscillator
EXT OSC
Section L
XMT-RCV
S9
Xmt
Rcv
L-R
R L
LEVEL
DISTN
1020-Hz BE Filter
Part of A6
CRSTLK
1020-Hz BP Filter
Part of A6
Rcv
Xmt
Section R
K2
2100Ω
48V
K1
POWER
Part of A5
Power Supply
−48V IN
Tip
48V OUT
Tip
−15V
−18V
−18V L
−18V-R
48V
SECTION R
A4
XMT ATTEN
Xmt
6.3 dB in
0.1 dB Steps
SEND LEVEL S8
In
Out
S5
2W 600Ω
K2
2
5
200
17
14
1.5k
8
In
Out
600
8
11
CHANNEL UNIT
1
2
3
4
T-R
CARR
DROP
7
8
5
6
E&M
87
5
600
600
87
A3
RCV ATTEN
Rcv
6.3 dB in
0.1 dB Steps
S6
2W 900Ω
8.5 dB Pad
S4
4W 600Ω
(Note 1)
9
10
11
12
T1 R1

Notes:

1. Main Signal Paths. Heavy lines show the main signal paths with XMT-RCV switch S9 in L-R position and VF INTFC pushbuttons S1 and S4 (4W 600Ω) depressed to "In" position.
2. VF INTFC Pushbuttons. The three pushbuttons (S1, S2, and S3 in Section L; S4, S5, and S6 in Section R) are interlocked so that only one can be "In" at the same time.
3. Resistors and Capacitors. Values are in ohms and microfarads.

Figure 3-25. 91443 Test Patch Panel, Circuit Diagram

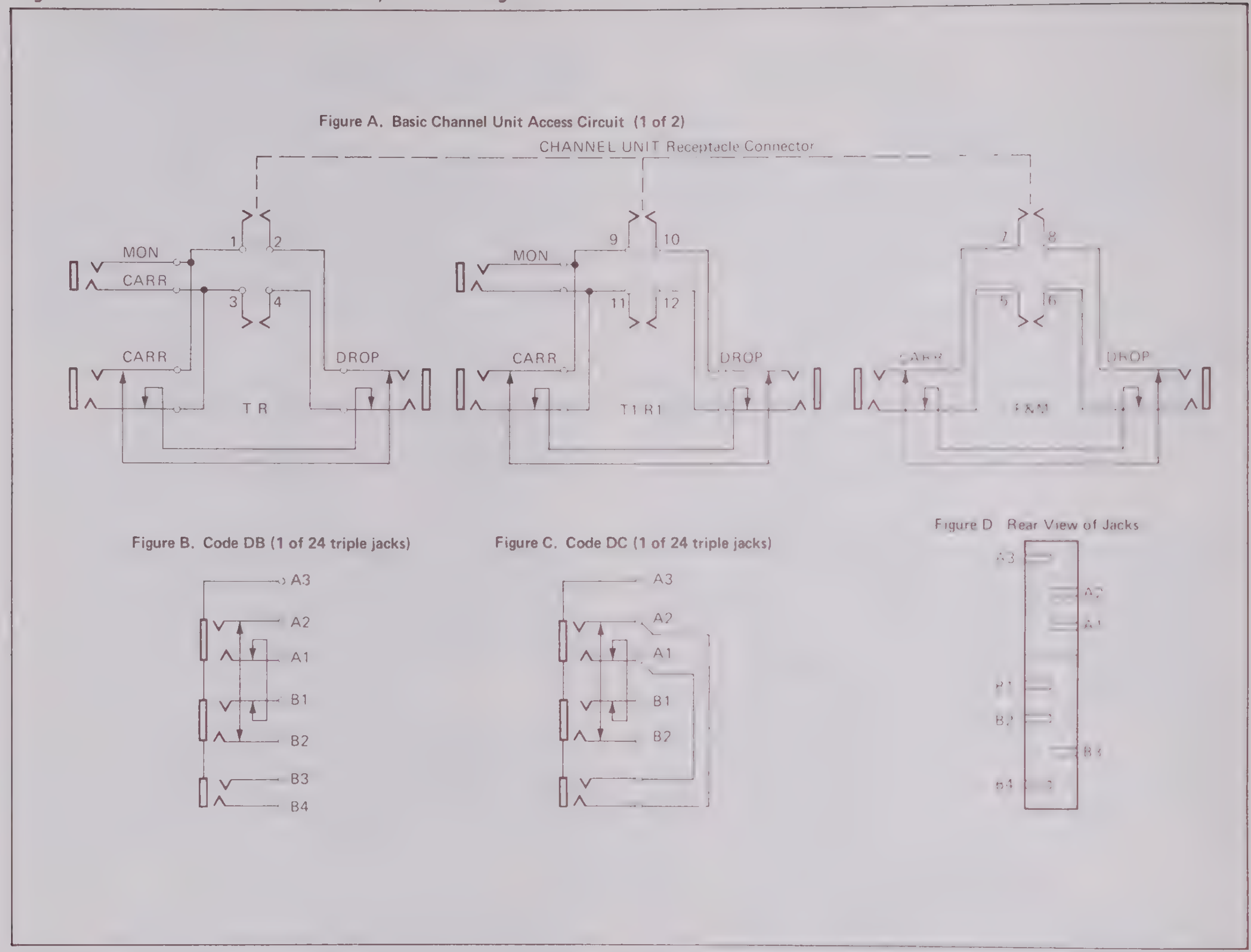


Figure A. Basic Channel Unit Access Circuit (1 of 2)
CHANNEL UNIT Receptacle Connector
MON
CARR
1
2
3
4
CARR
DROP
T R
MON
9
10
11
12
CARR
DROP
T1 R1
7
8
5
6
CARR
DROP
E&M
Figure B. Code DB (1 of 24 triple jacks)
A3
A2
A1
B1
B2
B3
B4
Figure C. Code DC (1 of 24 triple jacks)
A3
A2
A1
B1
B2
Figure D Rear View of Jacks
A3
A2
A1
B1
B2
B3
B4

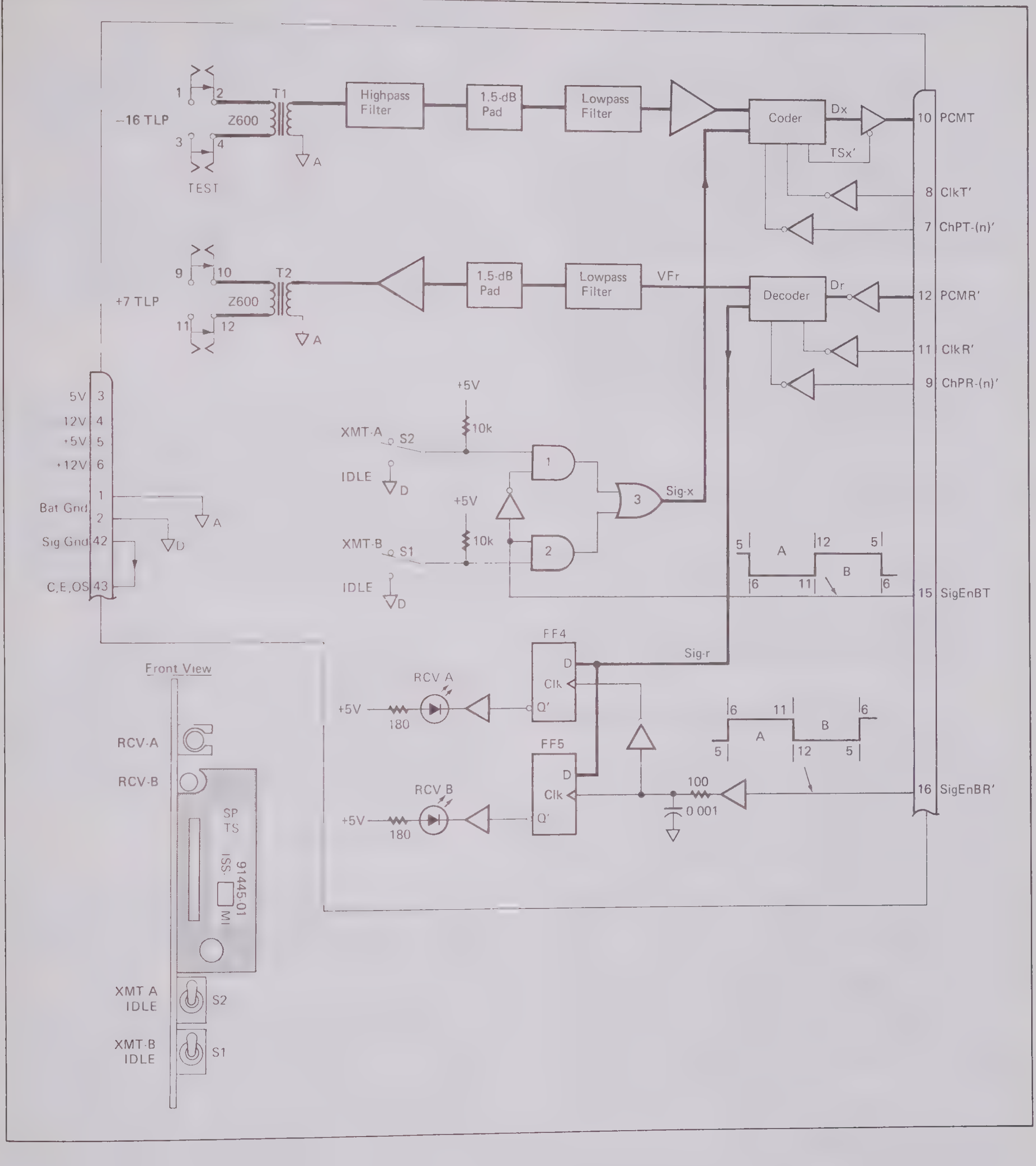
3.232 If the 91445 test set is being used in an end-to-end signaling test with a channel unit that receives the same information on both signaling channels, switches S2 and S1 should be operated simultaneously to the same position. Otherwise, the channel unit will receive opposite signaling states in alternate sixth frames. Trunk-type channel units such as 91402, 91403, 91404, and 91405 parallel the A and B signaling channels. Special-service channel units such as 91407, 91408, and 91409 use the A and B signaling channels independently.

3.233 Receive Signaling. In frames 6 and 12, bit 8 of the incoming channel word on Dr is latched in the decoder and output on Sig-r at the end of the frame. The signaling state remains on Sig-r during frames 7 through 12 for the A channel and during frames 1 through 6 for the B channel. At the start of frame 12, the inverted falling edge of SigEnBR′ clocks FF4, latching the A signaling state in the flip-flop. If Sig-r is logic 1, the Q′ output of FF4 goes low and lights the RCV-A indicator.

3.234 At the start of frame 6, the rising edge of SigEnBR′ clocks FF5, latching the B signaling state in the flip-flop. If Sig-r is logic 1, the Q′ output of FF5 goes low and lights RCV-B.

3.235 To prevent false triggering of the flip-flops, SigEnBR′ goes through a lowpass r-c filter (100 ohms and 0.001 μF) that suppresses high-frequency spikes without degrading the clock edges.

Figure 3-26. 91445 Signaling Path Test Set, Circuit Diagram


TEST
−16 TLP
+7 TLP
T1
T2
Z600
Highpass Filter
1.5-dB Pad
Lowpass Filter
Coder
Decoder
Dx
Dr
TSx'
VFr
10 PCMT
8 ClkT'
7 ChPT-(n)'
12 PCMR'
11 ClkR'
9 ChPR-(n)'
15 SigEnBT
16 SigEnBR'
5V 3
12V 4
+5V 5
+12V 6
Bat Gnd 1
2
Sig Gnd 42
C,E,OS 43
XMT-A S2
IDLE
XMT-B S1
+5V
10k
Sig-x
Sig-r
FF4
FF5
D
Clk
Q'
RCV A
RCV B
180
100
0.001
Front View
RCV-A
RCV-B
SP TS
ISS.
91445-01
MI
XMT A IDLE
XMT-B IDLE

4. ENGINEERING CONSIDERATIONS

Equipment Location

4.01 The channel bank should be located in an area of the office that provides adequate lighting and working space. Dusty environments must be avoided. Rear access is required for installation and maintenance.

4.02 The channel bank must not be mounted near sources of excessive heat such as furnace outlets, or above heat-producing units such as power supplies and tube-type equipment. The ambient temperature range and maximum relative humidity are specified in the Technical Summary.

4.03 To prevent heat buildup, a one-space ventilation baffle (Code AA of the 91400 shelf) installed directly above the channel bank is recommended. This is particularly important if the bank is equipped with dial-pulse originating (DPO) or foreign-exchange subscriber (FXS) channel units. Because of loop current, which is inversely proportional to loop length, heat dissipation is greater in DPO and FXS channel units than in other types.

NOTE: The baffle must be mounted on the rack so that it slopes up from the rear, directing the rising heated air out the grill at the front. Air flow into the equipment above enters at the rear of the baffle.

4.04 The ventilation baffle can usually be omitted under any of the following circumstances:

(a) Channel units are E&M types.

(b) The channel bank is in an air-conditioned electronic office.

(c) Other equipment above the channel bank breaks up the vertical heat rise.

4.05 If possible, install the channel bank at least 6 feet away from strong magnetic fields and sources of switching impulse noise that might be coupled into the channel bank circuits. Where space is limited, the noise effect may be reduced by changing the physical orientation of the source with the channel bank.

4.06 If more than four channel banks will be mounted on an equipment rack, cable congestion can be prevented by any one of the following:

(a) Use unequal-flange duct type racks (Section 788-161-070). Rear-mounting is standard on this type of rack.

(b) Separate adjacent racks by 3 inches.

(c) Mount the equipment at the rear of the rack.

Power Requirements

4.07 Channel bank dc power is obtained from the 48-volt office battery. Four lower voltages (+5V, −5V, +12V, and −12V) are derived from −48V by the 91425 Power Supply Unit and distributed to the common equipment units and channel units. Some units also use −48 volts directly as signaling battery or talking battery.

4.08 Figure 4-1 illustrates how to calculate the load on the office battery for a particular channel bank configuration. The figure shows the minimum and maximum current drain produced by the common equipment and by each type of channel unit. Values listed for DPO and FXS channel units do not include current to the external loop; this current must be estimated and entered in the space provided.

4.09 A 91424 Battery Filter Unit is required only if the channel bank will be equipped with one or more DPO or FXS channel units. The 91424 unit supplies filtered talking battery and fuse-protected 20-Hz ringing voltage, when required, via A and B distribution circuits to the two digroups.

4.10 As shown in figure 3-4, TB1-3 is strapped to TB1-4 and unfiltered office battery is routed through the 91424 unit to the channel units. If talking battery is available, the battery may be connected to TB1-4 and the strap to TB1-3 removed. However, the 91424 is still required because it provides "second-stage" filtering, which in previous equipment (9002B) was part of the loop battery feed circuit on DPO and FXS channel units.

Alarms

4.11 The channel bank has power, local, remote, and system alarm indicators. In each 91420 Alarm Control Unit, a system alarm relay has three sets of form C contacts for controlling office audible and visual alarms and an electronic office alarm (EAX alarm). The contact rating for noninductive loads is 1 ampere at 48 volts dc. To increase contact life and, more important, to suppress electrical noise, a contact protection circuit is required for an inductive load current over 10 mA or a load inductance greater than 0.5 henry. Protection networks should be installed as close as possible to the inductive load.

4.12 If a system alarm peg count is required, the EAX alarm contact can be used for counter control. A 91065 Counter Panel may be equipped with up to 11 electromechanical counters, which are actuated by a ground closure on the control lead. Figure 4-2 shows typical wiring from the 91420 units of one channel bank to a counter. This hookup utilizes wiring harness 088-56608-xx or 088-56609-xx, details of which appear on the 91455 Fuse and Alarm Panel circuit diagram in Section 342-911-112.

Cable Equalizers

4.13 The bipolar digital line signals of the 9004A channel bank are designated DS1C in mode 1 and mode 2 and DS1 in mode 3. At the standard cross-connect points, designated DSX-1C and DSX-1, the nominal signal level is 3-volts, base-to-peak.

4.14 As shipped from the factory, the channel bank is equipped with 6-dB pads at the two DS1 transmit lines and a 2-dB pad at the DS1C transmit line. The pads are soldered to standoff terminals on the printed circuit backplane. For the longer lengths of cable, the pad(s) must be replaced by one of two types of cable equalizers; see figures 4-3 and 4-4 for DS1 and DS1C cables, respectively. The equalizers, which are ordered as option codes of the 91400 shelf (see figure 5-1), are shipped loose for field installation. One DS1C equalizer is required for mode 1 or mode 2; two DS1 equalizers are required for mode 3. (The equalizers are the same types used in the 9102A, 9104A, 9122A, 9148A, and 4691B equipment.)

Office Wiring

4.15 External connections and strapping on the 91400 shelf are illustrated and described in the "Installation" part of GTEP Section 342-911-112. Some additional information for installation planning is given below.

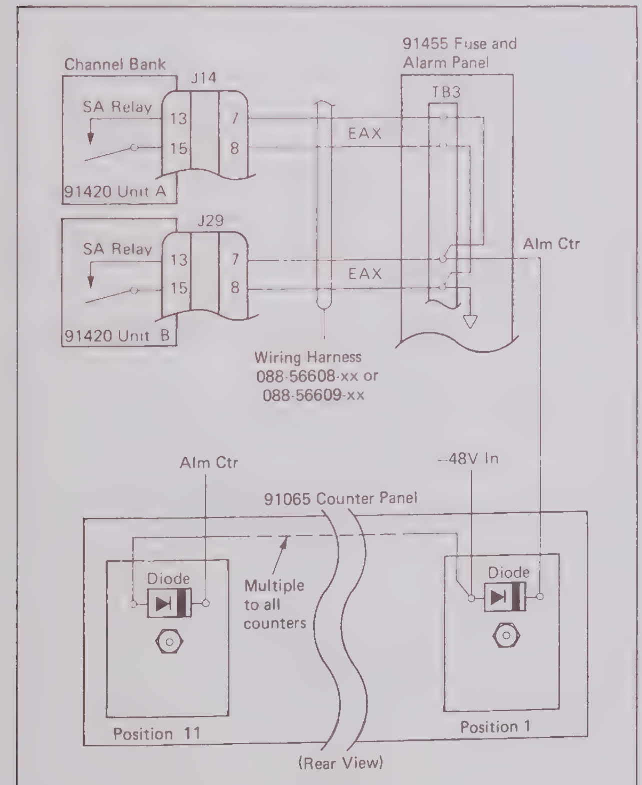
Figure 4-1. Sample Calculation of 9004A Channel Bank Load on the Office Battery

Common Equipment	Current, mA			Total Current, mA
	Normal	Looped		
Mode 1	355	434	.	
Mode 2	501	611	—	611
Mode 3	455	621	-	
Channel Units	Idle	Busy	Qty	
91401 4W	12	12		
91402 2W E&M	14	26		
91403 DPO	29	29	12	348
Loop current		100		1200
91404 4W E&M	13	25	24	600
91405 DPT	17	29	12	348
91407 4W Tandem	18	55		
91408 FXO	15	20		
91409 FXS	24	21		
Loop current		. . .		
	Maximum Load			3.107A

Notes:

1. Currents are based on office battery at 48.0 volts.
2. Loop currents are to be based on actual operating conditions. Battery feed resistance in the channel unit is about 400 ohms.

Figure 4-2. Application of 91065 Counter Panel



Note: Counters are installed from the front of the panel and retained by a spring clip.

4.16 Power. Because the channel bank has its own primary dc power fuse, office battery can be run directly to the shelf, eliminating the need for a fuse panel in the bay. Office battery, rack ground, and a 20-Hz ringing supply, if required, are wired to no. 5 screw terminals on barrier terminal board TB1. Alternatives to this arrangement are as follows:

(a) If separate battery ground and rack ground connections are required (in an electronic office, for example), remove the strap between TB1-1 and -2 and connect the battery ground lead to TB1-2.

(b) If a separate talking battery supply to the channel bank is provided, remove the strap between TB1-3 and -4 and connect the battery lead to TB1-4.

4.17 Wiring should be adequate to maintain at least 44 volts at the channel bank under conditions of maximum load and minimum office battery voltage. Wire sizes can be calculated according to the criteria presented in Section 795-001-070, with consideration that a channel bank could have a worst-case load up to 6.5 amperes. A 7-1/2 ampere fuse is recommended.

4.18 Office battery ground leads, minimum 6 AWG (4 mm), must be capable of handling currents up to 6.5 amperes per channel bank. The ground lead usually is terminated at a solderless connector attached to the equipment rack at the top. A ground wire of at least 16 AWG (1.25 mm) is to be connected from terminal board TB1 of each 91400 shelf to the equipment rack in accordance with GTEP Section 795-805-073.

4.19 Alarms. Three form C contacts of the system alarm relay in the 91420 Alarm Control Unit appear on receptacle connectors J14 (unit A) and J29 (unit B). If the rack assembly has a 91455 Fuse and Alarm Panel, the alarm circuits of all channel banks on the rack can be extended to and consolidated on the 91455 panel via wiring harness 088-56608-xx or 088-56609-xx described in figure 5-3. These harnesses have connectors that plug onto wirewrap terminals on J14 and J29 of up to six channel banks in the standard configurations of figure 6-1. Refer to the 91455 panel circuit diagram in Section 342-911-112.

NOTE: Wirewrapping to the 0.025-inch square terminals on J14 and J29 in the field is not recommended. For nonstandard rack configurations, wiring harness 088-56608-05 or -06, 3.7 metres (12 feet long), can be used to access the alarm circuits of one (-05) or both (-06) 91420 units.

4.20 Digital Lines. The transmit and receive DS1 or DS1C signals of the 9004A channel banks may be cabled in the same multipair shielded cable. Separation of the digital cabling and vf cabling is not necessary from an electrical standpoint but is recommended for physical protection of the pairs. Shielded cable should not be laced to the cable rack or cable rings. If lacing is necessary, the stitches should be loosely tied so that indentations are not made in the cable. Tight stitching could deform the cable sufficiently to change its electrical characteristics and, in extreme cases, might cause a shield-to-conductor short. When cable ties are used to secure cables to hexagonal studs, the studs must be insulated to prevent possible short circuits.

4.21 To prevent ground loops, DS1 and DS1C cable shields are usually grounded at the channel bank end only. Under special circumstances, field experience may indicate a need to ground the shield at both ends of the cable. Shield connections should be routed to the office ground in as short a distance as possible.

4.22 In this publication, reference is made to two types of shielded cable for DS1 and DS1C signals.

(a) GTE Specification GTS-8507: high-frequency terminating cable with 1, 5, 8, 10, or 12 individually shielded 22-gauge (0.63 mm) pairs; manufactured by General Cable Corp as type 4162.

Figure 4-3. DS1 Cable Lengths and Cable Equalizers

Cable From 9004A PCM Channel Bank to	Figure	Length of 22 Gauge Cable in Metres		Length of 22 Gauge Cable in Feet		DS1 Cable Equalizer in 9004A PCM Channel Bank (2 required)
		GTS 8507	GTS-8510 or ABAM	GTS-8507	GTS 8510 or ABAM	
DSX-1 cross-connect	A	0 to 14 14 to 90 90 to 166	0 to 17 17 to 108 108 to 200	0 to 46 46 to 294 294 to 544	0 to 55 55 to 355 355 to 655	No equalizer 087 56705 01 02
9104A (91101 Line Terminating Shelf); DSX-1 not used	B	0 to 37 37 to 113 113 to 189	0 to 46 46 to 137 137 to 229	0 to 123 123 to 371 371 to 621	0 to 150 150 to 450 450 to 750	No equalizer 087 56705 01 02
9104A (91140 Line Terminating Shelf equipped with 91124 Office Terminating Repeater Unit); DSX-1 not used	C	0 to 182 182 to 258 258 to 334	0 to 219 219 to 311 311 to 402	0 to 597 597 to 845 845 to 1,095	0 to 720 720 to 1,020 1,020 to 1,320	No equalizer 087 56705 01 02

Note: In figures A, B, and C, maximum 22-gauge cable lengths in metres (feet) are shown above and below the line, respectively, for GTS 8507 and GTS 8510 or ABAM cable.

Figure A

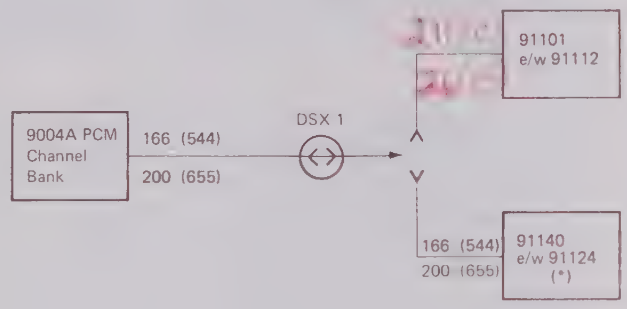

91101
e/w 91112
9004A PCM
Channel
Bank
166 (544)
200 (655)
DSX 1
166 (544)
200 (655)
91140
e/w 91124
(*)

Figure B

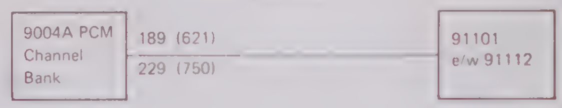
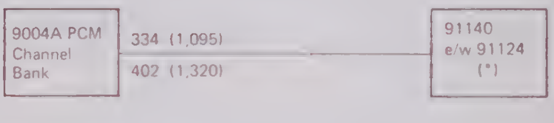

9004A PCM
Channel
Bank
189 (621)
229 (750)
91101
e/w 91112

Figure C


9004A PCM
Channel
Bank
334 (1,095)
402 (1,320)
91140
e/w 91124
(*)

*Or other DSX-1 compatible equipment

Figure 4-4. DS1C Cable Lengths and Cable Equalizers

Length of 22 Gauge Cable in Metres to DSX-1C		Length of 22 Gauge Cable in Feet to DSX-1C		DS1C Cable Equalizer (1 required)
GTS-8507	GTS-8510 or ABAM	GTS-8507	GTS 8510 or ABAM	
0 to 35 35 to 70 70 to 104	0 to 41 41 to 82 82 to 122	0 to 115 115 to 230 230 to 344	0 to 134 134 to 268 268 to 400	No equalizer 087 56705 03 04

Note: In figures A and B, maximum 22-gauge cable lengths in metres (feet) are shown above and below the line, respectively, for GTS 8507 and GTS 8510 or ABAM cable.

Figure A

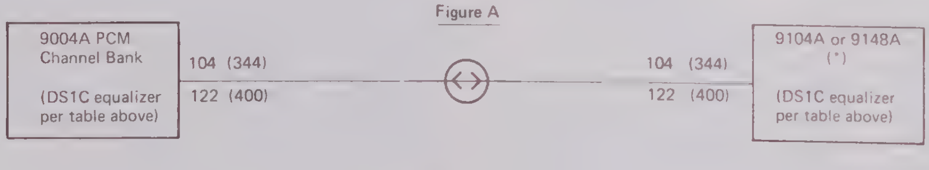
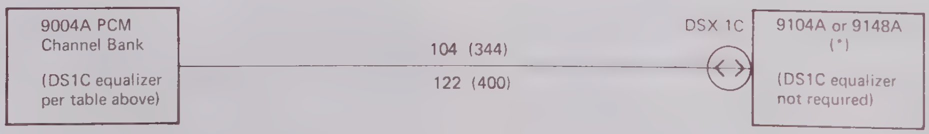

9004A PCM
Channel Bank
(DS1C equalizer
per table above)
104 (344)
122 (400)
104 (344)
122 (400)
9104A or 9148A
(*)
(DS1C equalizer
per table above)

Figure B


9004A PCM
Channel Bank
(DS1C equalizer
per table above)
104 (344)
122 (400)
DSX 1C
9104A or 9148A
(*)
(DS1C equalizer
not required)

*Or other DSX-1C compatible equipment

(b) **GTE Specification GTS-8510 or WECo ABAM:** multipair cable having unshielded 22-gauge (0.63 mm) pairs within a common shield; manufactured by General Cable Corp as type 4155. Because of its smaller diameter, this cable is preferred to GTS-8507.

Maximum cable lengths are included in figures 4-3 and 4-4. GTE Lenkurt stock numbers and other identifying numbers for GTS-8507 and GTS-8510 cables are listed in figure 4-5.

4.23 The transmit and receive digital lines connect to 1.14-mm (0.045-inch) square wirewrap terminals on the printed circuit backplane of the 91400 shelf. The XMT and

Figure 4-5. Identifying Numbers for GTS-8507 and GTS-8510 Cable.

No. of Pairs	GTE SML M/C	General Cable	GTE Lenkurt	EF&I
GTS-8507, Shielded 22-Gauge Pairs				
1	710851	4162A	112-00153-05	SC-64
5	710852	4162B	-06	-65
8	710853	4162C	-07	-66
10	710854	4162D	-08	-67
12	710855	4162E	-09	-68
GTS-8510, Unshielded 22-Gauge Pairs				
12	201212	6307946	163-10901-01	SC-34
26	201226	6307961	-02	-70
51	201251	6307987	-03	-71
101	201280	6308001	-04	-72

Figure 4-6. Cabling From 9004A Channel Bank to 5215B Jackfield and MDF

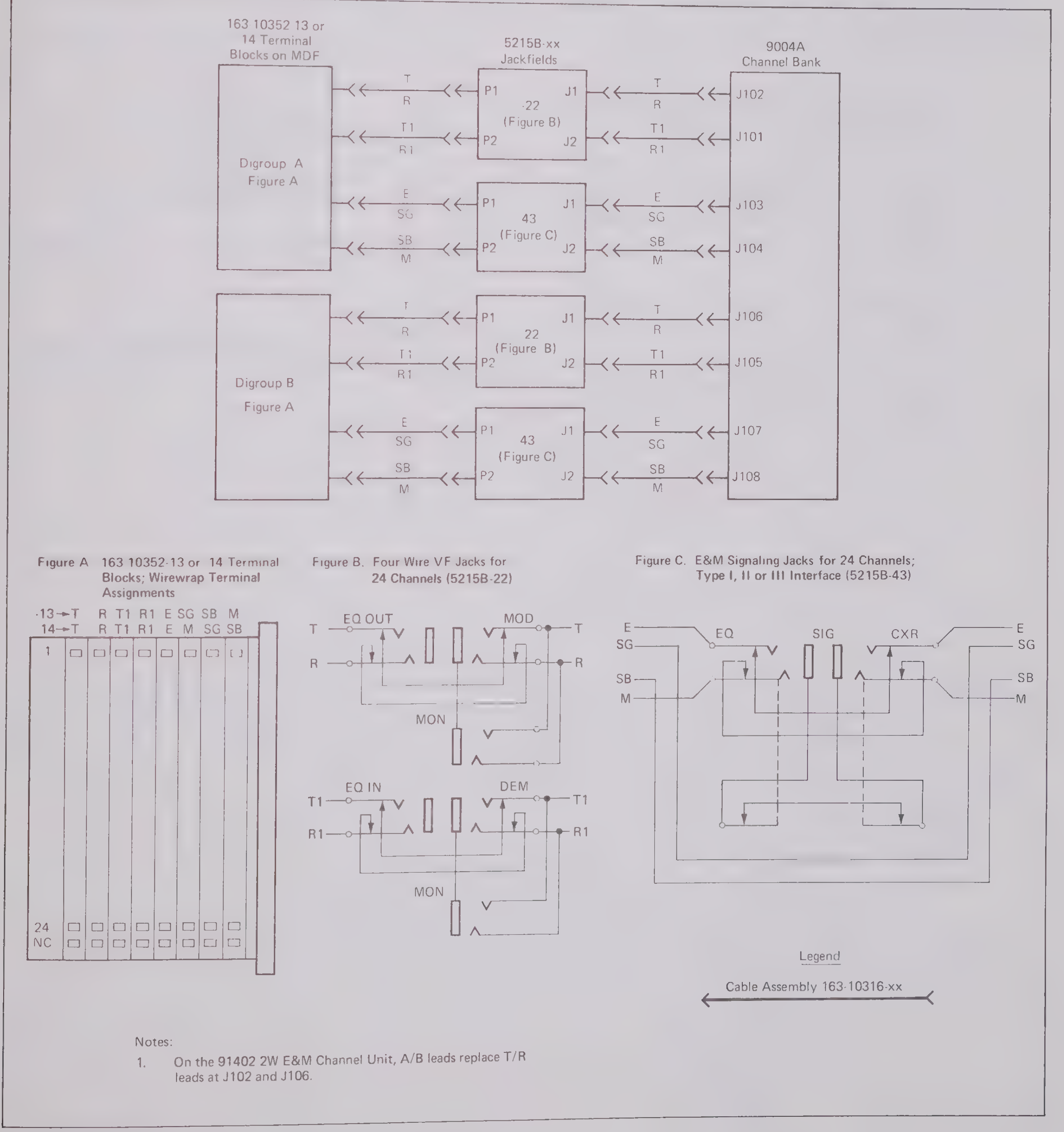

163 10352 13 or 14 Terminal Blocks on MDF
5215B-xx Jackfields
9004A Channel Bank
Digroup A Figure A
Digroup B Figure A
P1
P2
J1
J2
22 (Figure B)
43 (Figure C)
T
R
T1
R1
E
SG
SB
M
J102
J101
J103
J104
J106
J105
J107
J108
-13→T R T1 R1 E SG SB M
14→T R T1 R1 E M SG SB
1
24
NC
EQ OUT
MOD
MON
EQ IN
DEM
EQ
SIG
CXR
Legend
Cable Assembly 163-10316-xx

Figure A 163 10352-13 or 14 Terminal Blocks; Wirewrap Terminal Assignments

Figure B. Four Wire VF Jacks for 24 Channels (5215B-22)

Figure C. E&M Signaling Jacks for 24 Channels; Type I, II or III Interface (5215B-43)

Notes:

1. On the 91402 2W E&M Channel Unit, A/B leads replace T/R leads at J102 and J106.

RCV pairs of terminals are labeled A and B for the two digroups. If the channel bank operates in mode 1 or 2, the DS1C cable pairs are connected to XMT A and RCV A.

4.24 Two groups of six 1.14-mm (0.045-inch) square wirewrap terminals labeled A through F and G through M are located near the pad/equalizer mounting position. As specified on figure 3-1, two straps are required in each group.

4.25 VF and Signaling/Supervisory Circuits. Four pin-pairs on the channel units are preassigned to vf and signaling/supervisory circuits; for example, pins 35 and 36 are the T and R leads of a four-wire vf transmit circuit. The four pin-pairs are factory wired to 50-pin receptacle connectors J101 thorugh J108. Each connector accommodates one pin-pair from the 24 channels of one digroup; for example, pins 35/36 of channels 1A through 24A are wired to J102. The pin-pair assignments and typical wiring to the 50-pin receptacle connector are shown on figure 3-3.

4.26 The mating female plug connector for J101-J108, with solder-type or crimp-type wire terminals, is identified by one of the following part numbers:

Terminals	GTE Lenkurt	WECo
Solder-type, max 22 AWG (0.63 mm) solid wire	140-54655-02	KS-16690L-01
Crimp-type, max 24 AWG (0.5 mm) solid wire	140-54655-04	KS-16690L-12

4.27 For extending the channel circuits to the office equipment, GTE Lenkurt cable assemblies are available in lengths up to 300 feet; see 163-10315-xx and 163-10316-xx in figure 5-3. Also, channel circuits can be routed through the connectorized versions of the 5215B Miniature Jackfield Assembly (GTEP Section 342-521-100). Interconnections are made with the cable assemblies cited above and with connectorized terminal block 163-10352-xx. See figure 4-6.

5. EQUIPMENT IDENTIFICATION

5.01 Components of the 9004A PCM Channel Bank and associated equipment are identified and described in figures 5-1 through 5-5 as follows:

Figure	Description
5-1	Channel bank shelf and common equipment units.
5-2	Channel units; refer to the GTEP Sections listed in figure 1-2 for additional information.
5-3	Ancillary equipment, used with but not part of the 9004A.
5-4	Recommended test equipment; equivalent items may be substituted.
5-5	Replaceable parts and recommended spares.
5-6	Fuses.

5.02 For standard configurations of the channel bank and standard rack assemblies of three to six channel banks, see Part 6.

Figure 5-1. List of Common Equipment

Type No.	Name	Qty for Mode			Description
		1	2	3	
91400-01	Terminal Equipment Shelf	1	1	1	Supports and interconnects eight common equipment units and 48 channel units. NOTE: Because of heat dissipation requirements, if a ventilation baffle (Code AA) will not be installed directly above the shelf on the rack, the shelf must be equipped with a top plate (Code AB). Code AA Ventilation baffle 024-56830-01 and mounting hardware; one rack mounting space. AB Top plate 020-56735-01 and mounting hardware BA Channel assignment label 123-91400-01 and bracket 020-56730-01; for a front-mounted shelf; bracket attaches to shelf side plate. BB Channel assignment label 123-91400-01, bracket 020-56937-01, and mounting hardware; for a rear-mounted shelf on an unequal-flange duct type rack; bracket attaches to front of rack CA DS1 cable equalizer 087-56705-01 CB DS1 cable equalizer 087-56705-02 CD DS1C cable equalizer 087-56705-03 CE DS1C cable equalizer 087-56705-04
91420-01	Alarm Control Unit	1	2	2	Monitors channel bank performance and provides visual alarm indication and office alarm contacts
91421-01	Mode 1 Transmit Unit	1			Combines the eight-bit pcm words from 48 channels plus framing information into a single DS1C line signal; the format is not M1C compatible.
91422-01	Mode 2 Transmit Unit		1		For digroups A and B, combines the eight-bit pcm words from 24 channels plus framing information into two 1.576-Mb/s unipolar signals.
91423-01	Mode 3 Transmit Unit			1	For digroups A and B, combines the eight-bit pcm words from 24 channels plus framing information into two 1.544-Mb/s DS1 line signals.
91424-01	Battery Filter Unit	1	1	1	Optional; supplies talking battery to DPO and FXS channel units and 20-Hz ringing voltage to FXS channel units.
91425-01	Power Supply Unit	1	1	1	From a —48 volt dc input, supplies regulated dc voltages to units of the 91400-01 shelf. Voltages and maximum loads are: +5V at 3.6A, —5V at 0.25A, +12V at 0.8A, and —12V at 0.4A.
91426-01	Syndes Unit		1		Synchronizes and combines transmit signals of digroups A and B plus control bits into an M1C-compatible DS1C line signal; performs a reciprocal function in the receive direction.
91431-01	Mode 1 Receive Unit	1			Demultiplexes the incoming DS1C line signal to recover the digital vf and signaling information for 48 channels.
91432-01	Mode 2 Receive Unit		1		Demultiplexes the unipolar pcm bit streams from the 91426 Syndes Unit to recover the digital vf and signaling information for 48 channels.
91433-01	Mode 3 Receive Unit			1	Demultiplexes two incoming DS1 line signals to recover the digital vf and signaling information for 48 channels.
91448-01	Office Interface Unit (future)	1	1	1	Optional; extends alarm and control leads to a supervisory and control system such as GTE Lenkurt System 51.

Figure 5-2. List of Channel Units (Sheet 1 of 2)

Type	Channel Unit	Drop Impedance	Drop Levels		Features and Codes	Signaling and Supervisory Strapping Options
			Transmit	Receive		
E&M	91402-xx Two-Wire E&M (model 2)	-01: 900Ω +2.15 μF -02: 600Ω +2.15 μF	—4.5 to +1.8 dBm	0 to 6.3 dBm	C1 lead (Code A) NBOC (Note 1) A and B leads, 80 mA	Signaling interface: Sig Lead / Intfc Type / On-hook/Off-hook E / I, III Std / Open/ground I PLR / Ground/battery II / Open/closed M / I, III Std / Ground/battery I PLR / Open/ground II / Open/battery E lead during system alarm: On-hook Off-hook On-hook 2 seconds, then off-hook NORM/BUSY switch in BUSY: Local busy Remote busy Local and remote busy Signaling battery source: Internal External via F lead Midpoint capacitor for A and B leads (91402-xx): Internal External
	91404-01 Four-Wire E&M (model 2)	600Ω	—17.5 to —11.2 dBm (Note 2)	+8.5 to +2.2 dBm (Note 2)	C1 lead (Code A)	

Figure 5-2. List of Channel Units (Sheet 2 of 2)

Type	Channel Unit	Drop Impedance	Drop Levels		Features and Codes	Signaling and Supervisory Strapping Options
			Transmit	Receive		
Loop	91403-01 Dial Pulse Originating (DPO)	900Ω + 2.15 μF	—4.5 to +1.8 dBm	0 to —6.3 dBm	CPFR NBOC (Note 1) 1800Ω loop	C lead busied by: Transmit off-hook Transmit or receive off-hook SxS selector: Open-seeking Battery-seeking Control/alarm leads: C OS or S B1-B2 ATB lead and: EC lead Peg-count lead, 100-ms ground pulse CPFR: With delay-dial or wink supervision With answer supervision No CPFR Battery at two-wire port: Normal battery in alarm Delayed (2 s) reverse battery in alarm Nonreversing battery
	91405-01 Dial Pulse Terminating (DPT)	900Ω + 2.15 μF	—4.5 to +1.8 dBm	0 to —6.3 dBm	Pulse corrector (Code A) C lead NBOC (Note 1) Seize 900Ω loop, pulse 200Ω loop	Off-hook wink is transmitted as a signaling integrity check when C lead is closed to ground externally after seizure. Reverse-to-normal transition on two-wire drop produces an extended guard delay of 40 or 200 ms; with Code A, the delay is 600 ms.
No sig	91401-01 Four-Wire (model 2)	600Ω	—17.5 to —11.2 dBm (Note 2)	+8.5 to +2.2 dBm (Note 2)		
FX	91407-01 Four-Wire Tandem	600Ω	—17.5 to —11.2 dBm (Note 2)	+8.5 to +2.2 dBm (Note 2)	Eight-wire interface; electronic signaling leads E1, E2, M1, and M2	
	91408-01 Foreign Exchange Office (FXO) (model 2)	600 or 900Ω + 2.15 μF	—10.9 to +1.8 dBm	+2.0 to —10.7 dBm	NBOC (Note 1) Pulse corrector 087-57028-01 (Code A); not on model 1 Balance network (Note 3) Seize 1300Ω loop, pulse 800Ω loop	Signaling mode: Loop start Ground start Signaling format: No. 3 EAX interface D3/D4 Trunk-make-busy: Idle; with or without C lead Idle 2 seconds, then busy; with or without C lead
	91409-01 Foreign Exchange Subscriber (FXS) (model 2)	600 or 900Ω + 2.15 μF	—10.9 to +1.8 dBm	+2.0 to —10.7 dBm	NBOC (Note 1) Balance network (Note 3) 1800Ω loop	Signaling mode: Loop start Ground start Auto ringdown (not on model 1) Signaling format: No. 3 EAX interface D3/D4 and auto ringdown (not on model 1) Trunk-make-busy: Idle; ringing inhibited Idle 2 seconds, then busy

Notes:

1. NBO Capacitance. NBOC is strappable from 0 to 0.126 μF in 0.002-μF steps.
2. Four-Wire VF Drop Levels. Transmit and receive levels shown for the 91401, 91404, and 91407 channel units are for nontandem applications with the TANDEM attenuators strapped for 0 dB. Level ranges for all settings of the TANDEM attenuators are listed in figure 3-8.
3. Balance Networks. Optional hybrid balance networks for the 91408 and 91409 FX channel units are listed below:

Code	Part Number	Cable Loading and Gauge
AA	087-56976-01	H88 loading; 19 or 22 AWG (0.9 or 0.63 mm)
AB	087-56977-01	H88 loading; 24 or 26 AWG (0.5 or 0.4 mm)
AC	087-56975-01	D66 loading; 19 or 22 AWG (0.9 or 0.63 mm)
AD	087-56978-01	Nonloaded cable

Figure 5-3. List of Ancillary Equipment

Type/Part Number	Name	Description
3000A-xx	Transport and Storage Shelf	-01 Rack-mounting shelf; requires three or four mounting spaces; has 22 slots for plug-in units; adjustable for units that are two, three, or four mounting spaces high. -02 Same as -01 except without rack mounting brackets.
5215B-xx	Miniature Jackfield Assembly	Connectorized jackfield with up to 96 single or double miniature telephone jacks; one rack mounting space. See GTEP Section 342-521-100. -22 Normal-through jacks and monitor jacks for 24 four-wire vf channels; line and drop sides of jacks are wired to four chassis-mounted 50-pin connectors. -25 Bell System standard interbay patch jacks (mod, demod, and sig) for 24 channels; each jack is bridged on a through-path between two (In and Out) of six chassis-mounted 50-pin connectors; includes unwired jacks for access to battery, ground, and milliwatt supply. In a typical application, one jackfield is installed on the center rack of a three-rack group. Jackfields of adjacent three-rack groups are interconnected by three 163-10316-xx Cable Assemblies. This provides 24 six-wire patching paths accessible to all channels on the racks. The jackfields are not cabled to the channel banks. -26 Same as -25 except wired per GTE Lenkurt standard. -27 Normal-through jacks for 48 two-wire vf channels; line and drop sides of jacks are wired to four chassis-mounted 50-pin connectors. -43 Normal-through E&M signaling jacks for 24 channels; type I, II or III interface; E on tip, M on ring, SG and SB wired through; line and drop sides of jacks are wired to four chassis-mounted 50-pin connectors. Code AC Two brackets that extend jackfield 105 mm (4-1/8 inches) from rack.
56620-01	Writing Shelf	Retractable unit that can be installed as a writing shelf or a storage drawer; one rack mounting space; mounts from front or rear of channel-type or duct-type rack.
91065-01	Counter Panel	Rack-mounting chassis (one space) that accommodates 11 counters (Code A). Code A Three-digit electromechanical totalizing counter with mechanical reset button; nominal operating voltage, 48 volts dc; coil resistance, 2,000 ohms ±10%; maximum counting speed, 20 impulses/second; minimum off-time between impulses, 25 milliseconds .
91455-01	Fuse and Alarm Panel	Distributes —48V to six channel banks and associated equipment through nine GMT alarm-type fuses; maximum current 55 amperes; has terminals for connecting nine ground distribution circuits; has a 60-point wirewrap terminal block for interconnecting office alarm equipment and channel bank alarm circuits; has fuse alarm and bay alarm relays with form C dry contacts to control office alarm equipment; one rack mounting space. See GTEP Section 342-911-112 for circuit diagram.
088-56608-xx	Wiring Harness	Extends channel bank alarm circuits to a 60-point wirewrap terminal block on a 91455 Fuse and Alarm Panel mounted at the top of the rack; has 10-pin connectors that plug onto wirewrap terminals of receptacle connectors J14 and J29 for the 91420 Alarm Control Units. -01 For rack assembly 91004-20 with six banks. -02 For rack assembly 91004-21 with five banks. -03 For rack assembly 91004-30 or -32 with four banks. -04 For rack assembly 91004-31 with three banks. -05 Nine-conductor wiring harness 3.7 metres (12 feet) long terminated at a 10-pin connector; for access to one 91420 unit on nonstandard rack configurations. -06 Similar to -05 but with two connectors for access to both 91420 units of a channel bank in mode 2 or mode 3.
088-56609-01	Wiring Harness	Same as 088-56608 except 91455 is mounted near the middle of the rack; for rack assembly 91004-22 or -23 with five banks and 91004-33 or -34 with three banks.
163-10315-xx	Cable Assembly	25-pair, 24-gauge cable with 50-pin female connector on one end, length in metres (feet) as listed below; mates with J101 through J108 on 91400 shelf. -05 7.5 (25) -25 38 (125) -45 69 (225) -10 15 (50) -30 46 (150) -50 76 (250) -15 23 (75) -35 53 (175) -55 84 (275) -20 30 (100) -40 61 (200) -60 91 (300)
163-10316-xx	Cable Assembly	25-pair, 24-gauge cable with two 50-pin connectors, male on one end and female on the other, length in metres (feet) as listed below; female connector mates with J101 through J108 on 91400 shelf. -01 1.5 (5) -10 15 (50) -35 53 (175) -02 3 (10) -15 23 (75) -40 61 (200) -03 4.5 (15) -20 30 (100) -45 69 (225) -04 6 (20) -25 38 (125) -50 76 (250) -05 7.5 (25) -30 46 (150) -55 84 (275) -60 91 (300)
163-10352-xx	Connectorized Terminal Block	8 x 25 terminal block for installation on MDF; wirewrap terminals 1 x 1.4 mm (0.040 x 0.055 inch); five 50-pin female connectors. See figure 4-6 for application. -13 Front-to-rear terminal assignments on block are T/R, T1/R1, E/SG, and SB/M. -14 Front-to-rear terminal assignments on block are T/R, T1/R1, E/M, and SG/SB.

Figure 5-4. List of Recommended Test Equipment

Qty per Site	Test Equipment (GTE Lenkurt unless otherwise specified)	Notes	Description and Use
1	91232 Test and Alignment Set	1	Provides a vf measuring circuit used in conjunction with external meters; supplies 1025-Hz test tone at 0 or −16 dBm; two rack mounting spaces. The digital section of the 91232 is for testing 9002A/B channel banks and is not applicable to 9004A. (GTEP Section 342-911-103 or -107)
1	91442 VF Test Set	1	Portable or rack-mounting test set for measuring transmission level, noise, distortion, and crosstalk on an external meter such as a TTS-37B Noise Measuring Set; contains a 1020-Hz test-tone generator; connects to the channel unit TEST connector through a 796A Patch Cord; direction of test can be reversed without altering test setup; three rack mounting spaces. See figure 3-24.
1	91443 Test Patch Panel See added	1	Interface between the channel unit TEST connector and external test equipment, including the 91232 Test and Alignment Set; one rack mounting space. See figure 3-25. Code DB Jack block equipped with 24 triple miniature trs jacks; normal-through jacks and unwired monitor jack; wirewrap terminals. DC Same as Code DB except monitor jack is wired to normal-through jacks. DE Jack block for 24 triple miniature trs jacks (not equipped).
1	~~91444~~ Test Shelf [illegible]		Maintains one set of common equipment and two channel units in an operating condition on a looped basis; the condition of a unit removed from a working bank can be verified by substituting it in the test shelf; three rack mounting spaces. Additional 91444 shelf plug-ins are 91446 Signaling/Interface Unit and 91447 Selector Unit. (GTEP Section 342-911-125)
1	91445 Signaling Path Test Set		Four-wire channel unit modified for vf and signaling tests on any channel; transmit/receive levels are a fixed −16/+7 dBm at the TEST connector; A and B signaling channels have toggle switches for transmit control and LED's for receive indications. See figure 3-26.
1	26600 Signaling Test Set		Sends signaling pulses at selected rate and percent break; receives signaling pulses and measures percent break. (GTEP Section 108-402-106)
1	Northeast Electronics TTS-37B Noise Measuring Set	2	Noise and level measuring test set with switch-type weighting networks and hold coil.
1	Northeast Electronics TTS-58A-CN Impulse Noise Counter		Counts number of pulses exceeding a selected level over a selected time interval.
1	Hewlett-Packard 204C Oscillator	2	For optional frequency response tests, 200 to 3400 Hz at 0 dBm.
1	Simpson 260-6 Volt-Ohm-Milliammeter		General-purpose multimeter with 20,000-ohms/volt sensitivity.
2	725A Cord (135-42822-01)		Two-conductor cable 3.6 metres (12 feet) long wired between tip and sleeve of two 310-type tip-ring-sleeve telephone plugs; used to supply −48V power to 26600, TTS-37B, TTS-58A, and 91442.
2	796A Patch Cord (035-56967-xx)		Twelve-conductor cable with a double-sided printed circuit plug connector on each end; connects TEST receptacle connector on channel unit to CHANNEL UNIT receptacle connector on 91442 VF Test Set or 91443 Test Patch Panel; also usable for restoration patching between certain channel units. -01 1.8 metres (6 feet) long; 035-56967-01 -02 3.6 metres (12 feet) long; 035-56967-02
2	6000A-01 600-Ohm Terminating Plug (135-53521-01)		Miniature telephone plug with a 600-ohm resistor between tip and ring.
2	6100B-02 Cord (135-56150-02)		Shielded two-conductor cable 3.0 metres (10 feet) long with a miniature tip-ring-sleeve telephone plug on one end and a twin banana plug on the other end; equivalent to 6000B-02.
2	6100C-02 Cord (135-56151-02)		Shielded two-conductor cable 3.0 metres (10 feet) long with a miniature tip-ring-sleeve telephone plug on each end; equivalent to 6000C-02.
2	6100D-02 Cord (135-56152-02)		Shielded two-conductor cable 3.0 metres (10 feet) long with a 310-type tip-ring-sleeve telephone plug on one end and a miniature tip-ring-sleeve telephone plug on the other end; equivalent to 6000D-02.
2	141-54484-01 Open Plug		Dummy (plastic) miniature telephone plug.

Notes:

1. Channel Performance Tests. Designed specifically for the 9004A PCM Channel Bank, the 91442 VF Test Set is recommended for channel performance tests. The combination of a 91232 Test and Alignment Set and a 91443 Test Patch Panel is an alternative.
2. Transmission Test Set. Northeast Electronics TTS-44 Transmission Test Set may be used as an alternative to the TTS-37B for level and noise measurements. It may also be used as a signal generator for frequency response tests in lieu of the Hewlett-Packard 204C Oscillator.
3. Test Cords. GTEP Section 032-201-150 gives a complete listing of GTE Lenkurt test cords, plugs, and adapters.

See added

796A
796C

Figure 5-5. List of Replaceable Parts

Item	Ordering No.	Quantity Used	Recm Spares, Min per Site
Common equipment units; see figure 5-1 and/or 6-1C		1 set	1 set for 1 to 20 banks
Channel unit; see applicable GTEP Section listed in figure 1-2		48 max	1 per bank
Light-emitting diode, red (BUSY)	174-53465-03	1	
Strapping plug	141-56699-01	20 typical	10
91400 Terminal Equipment Shelf			
Bracket (see Code BA, figure 5-1)	020-56730-01	1	
Bracket (see Code BB, figure 5-1)	020-56937-01	1	
Clip, electrical (strap on TB1)	137-49295-01	2	
Connector, 10-pin; Molex 09-50-7101 (mates with J14 and J29)	140-54174-06	2	
Contact, electrical; Molex 08-56-0108	140-54175-01	18	
Cover, fuse; plastic	122-71501-01	6	5
Cover, rear; insulating	024-56680-01	1	
Equalizer, cable, DS1 (see Codes CA and CB, figure 5-1)		2	
Equalizer, cable, DS1C (see Codes CD and CE, figure 5-1)		1	
Extractor, strapping plug	020-56788-01	1	1
Fuse, type GMT; 1-ampere	175-28996-01	1	10
Fuse, type GMT; 2-ampere	175-28996-03	3	10
Fuse, type GMT; 3-ampere	175-28996-07	2	10
Label, channel assignment	123-91400-01	1	
Light-emitting diode, red	174-53465-03	2	
Pad, 6-dB	087-56939-01	2	
Pad, 2-dB	087-56939-02	1	
Screw, shoulder; 4-40 x 7/8 (for J101-J108)	125-56426-01	16	
Strapping plug (Y/Z)	141-56699-02	1	1
Strapping plug (channel unit TMB)	140-56464-02	48	2
Top plate (see Code AB, figure 5-1)	020-56735-01	1	
Ventilation baffle (see Code AA, figure 5-1)	024-56830-01	1	
91420 Alarm Control Unit			
Knob, push; black	126-51993-04	3	
Lamp, 48-volt	184-28343-03	1	2
Lens, slip-on; yellow	138-43523-03	1	
Light-emitting diode, red	174-53465-03	1	
Light-emitting diode, white-red	174-53465-06	2	
Light-emitting diode, yellow	174-53465-07	1	
Light-emitting diode, green	174-53465-08	1	
Strapping plug	141-56699-01	1	
91421, 91422, or 91423 Transmit Unit			
Strapping plug	141-56699-01	4	
91424 Battery Filter Unit			
Cover, fuse; plastic	122-71501-01	4	
Fuse, type GMT; 0.18-ampere	175-28996-04	2	10
Fuse, type GMT; 2-ampere	175-28996-03	2	10
91425 Power Supply Unit			
Light-emitting diode, red	174-53465-02	1	
91426 Syndes Unit			
Light-emitting diode, red	174-53465-03	2	
Light-emitting diode, green	174-53465-04	1	
Light-emitting diode, yellow	174-53465-07	1	
91431, 91432, or 91433 Receive Unit			
Light-emitting diode, red	174-53465-03	2	
Light-emitting diode, green	174-53465-08	2	
91443 Test Patch Panel			
Connector, receptacle; 12-pin	040-56657-01	2	
Jack, telephone (T-R and T1-R1)	139-10666-81	4	
Jack, telephone (E&M)	139-10666-62	2	
91445 Signaling Path Test Set			
Light-emitting diode, red	174-53465-03	2	
91455 Fuse and Alarm Panel			
Diode, power; 2 amperes	174-19529-05	5	
Fuse, type GMT; 7.5-ampere	175-28996-12	6	10
Fuses; see figure 5-6 for additional sizes			
Label, fuse identification	023-91455-01	1	
Lamp, miniature; 48 volts, 40 mA	184-10955-28	2	2
Lens, red	138-56416-06	2	
Relay; 48 volts (K1)	185-28397-01	1	
Relay; 12 volts (K2)	185-28340-01	1	
Resistor, flameproof; 4 watts, 140 ohms ±1%	169-43001-04	2	
Resistor, flameproof; 10 watts, 450 ohms ±5%	169-43004-34	1	

Figure 5-6. List of Fuses

Reference Designation	Rating, Amperes	Circuit
91400 Terminal Equipment Shelf		
F1	1	—48V to AUX jack
F2	2	—48V to 91425 Power Supply Unit
F3, F4	2	Signaling battery
F5, F6	3	Talking battery
91424 Battery Filter Unit		
F1, F3	2	20 Hz to FXS channel units; master fuses
F2, F4	0.18	Alarm; slave fuses to F1 and F3
91455 Fuse and Alarm Panel (Note 1)		
F1 thru F6	7-1/2	—48V to channel banks No. 1 thru No. 6
F7, F8	7-1/2 max	—48V to auxiliary equipment
F9	1 max	—48V to auxiliary equipment; from diode-isolated A and B inputs

Notes:

1. 91455 Panel. Fuses are not supplied with the panel and must be ordered separately. The total current drain should not exceed 55 amperes.
2. Fuses. Fuses listed above are GMT alarm-type. Available sizes are identified below:

Rating, Amperes	Color Code	GTE Lenkurt Stock Number
0.18	Yellow	175-28996 -04
1/4	Violet	-05
1/2	Red	-09
3/4	Brown	-06
1	Gray	-01
1-1/3	White	-02
2	Orange	-03
3	Blue	-07
5	Green	-10
7-1/2	Black-White	-12

6. STANDARD ASSEMBLIES

Rack Assemblies

6.01 Standard rack arrangements of three to six channel banks (144 to 288 channels) are illustrated in figure 6-1; the ordering numbers are in figure 6-1A.

6.02 Rack. In addition to the ordering number (91004-xx), the rack type and height must be specified; see figure 6-1B. Assemblies in figure 6-1 are on minimum height racks. If a taller rack is ordered, the equipment will occupy the same numbered mounting positions shown.

6.03 Equipment Mounting. Unless rack assemblies are ordered otherwise, equipment will be front- or rear-mounted as specified below. (Mounting the equipment on the rear of the rack provides more cabling space.)

(a) Unequal-flange, duct-type racks (31000-xx): rear-mounted

(b) Self-supporting, channel-type racks (31051-xx): front-mounted

(c) Overhead-supported, channel-type racks (31052-xx)

(1) Height 2.44 or 2.74 m (8′ or 9′): front-mounted
(2) Height 3.50 or 3.56 m (11′6″ or 11′8″): rear-mounted

6.04 91400 Shelf. A 91400 shelf furnished as part of a rack assembly will include code AA or AB, as applicable. The channel assignment label and bracket (code BA or BB) and the DS1 or DS1C cable equalizers (codes CA through CE) must be ordered, if required. The quantity of cable equalizers is two DS1 or one DS1C.

6.05 Plug-Ins. Plug-in units for the channel bank are not included with the standard rack assemblies and must be ordered. Common equipment units can be ordered as a set from figure 6-1C or individually from figure 5-1. Channel units are ordered by type no. (including dash no.) and any applicable code; see figure 5-2.

6.06 Ancillary Equipment. Ancillary equipment, such as jackfields, and rack-mounted or portable test equipment also must be ordered separately; see figures 5-3 and 5-4.

6.07 Fuses. Refer to figure 5-6 for a listing of fuses required and fuses supplied with the equipment.

6.08 Test Set. The test set called out on the rack layouts is the 91442 VF Test Set, which occupies three rack mounting spaces. Alternatively, a 91232 Test and Alignment Set (two spaces) and a 91443 Test Patch Panel (one space) may be substituted.

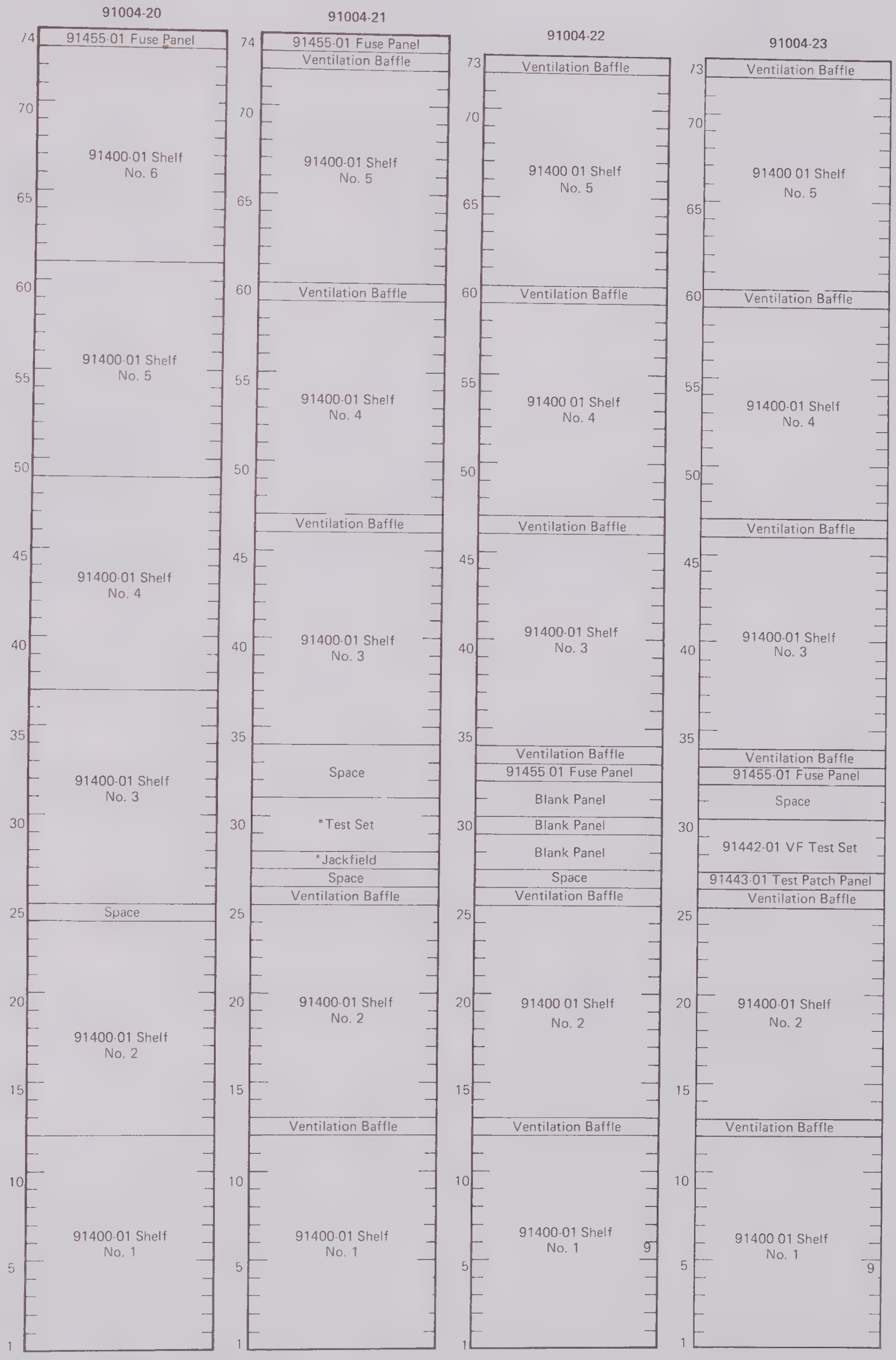
6.09 Rack Wiring. Standard rack assemblies include wiring harness 088-56608-xx or 088-56609-xx connecting the channel bank alarm circuits to the 91455 Fuse and Alarm Panel. In addition, TB1-3 on each channel bank is wired to the applicable -48V fuse on the 91455 panel and TB1-1 is wired to rack ground.

6.10 Drop Cables. Cables are not included and must be ordered according to the channel vf and signaling/supervisory circuit requirements. See 163-10315-xx and 163-10316-xx in figure 5-3.

Common Equipment

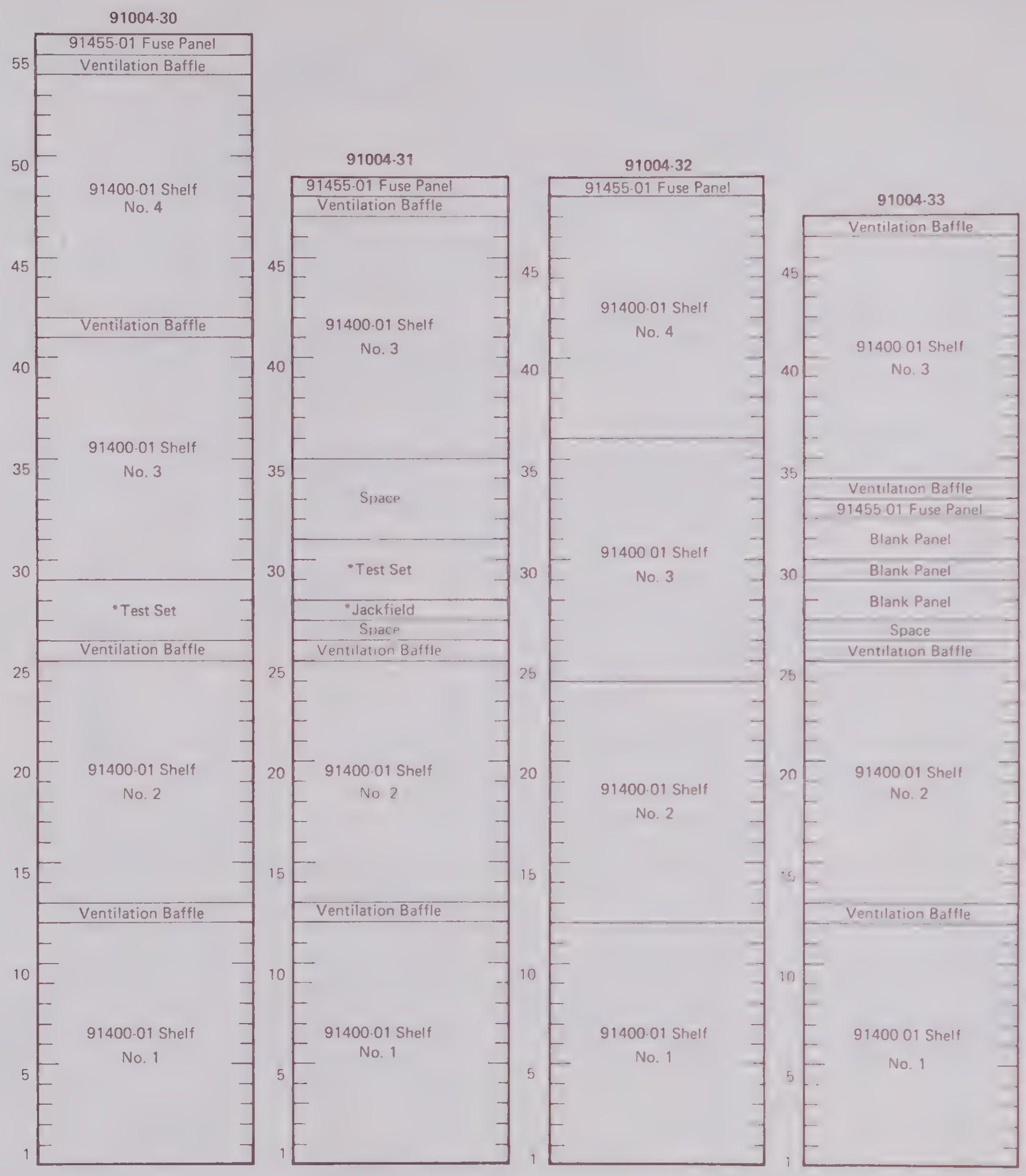
6.11 In figure 6-1C, ordering numbers are listed for a single 91400 Terminal Equipment Shelf with plug-in common equipment units and for loose sets of plug-ins. The shelf will not include coded items unless they are specifically ordered. The 91424 Battery Filter Unit, required when the channel bank includes DPO or FXS channel units, must be ordered separately; see figure 5-1.

Figure 6-1. Standard Assemblies (Sheet 1 of 3)


91004-20
74
91455-01 Fuse Panel
70
91400-01 Shelf No. 6
65
60
91400-01 Shelf No. 5
55
50
91400-01 Shelf No. 4
45
40
35
91400-01 Shelf No. 3
30
25
Space
20
91400-01 Shelf No. 2
15
10
91400-01 Shelf No. 1
5
1
91004-21
74
91455-01 Fuse Panel
Ventilation Baffle
70
91400-01 Shelf No. 5
65
60
Ventilation Baffle
55
91400-01 Shelf No. 4
50
Ventilation Baffle
45
91400-01 Shelf No. 3
40
35
Space
30
*Test Set
*Jackfield
Space
Ventilation Baffle
25
20
91400-01 Shelf No. 2
15
Ventilation Baffle
10
91400-01 Shelf No. 1
5
1
91004-22
73
Ventilation Baffle
70
91400 01 Shelf No. 5
65
60
Ventilation Baffle
55
91400 01 Shelf No. 4
50
Ventilation Baffle
45
91400-01 Shelf No. 3
40
35
Ventilation Baffle
91455 01 Fuse Panel
Blank Panel
30
Blank Panel
Blank Panel
Space
Ventilation Baffle
25
20
91400 01 Shelf No. 2
15
Ventilation Baffle
10
91400-01 Shelf No. 1
9
5
1
91004-23
73
Ventilation Baffle
70
91400 01 Shelf No. 5
65
60
Ventilation Baffle
55
91400-01 Shelf No. 4
50
Ventilation Baffle
45
91400-01 Shelf No. 3
40
35
Ventilation Baffle
91455-01 Fuse Panel
Space
30
91442-01 VF Test Set
91443-01 Test Patch Panel
Ventilation Baffle
25
20
91400-01 Shelf No. 2
15
Ventilation Baffle
10
91400 01 Shelf No. 1
5
9
1

*Not included in standard assembly; order separately.

Figure 6-1. Standard Assemblies (Sheet 2 of 3)


91004-30
91455-01 Fuse Panel
Ventilation Baffle
91400-01 Shelf No. 4
Ventilation Baffle
91400-01 Shelf No. 3
*Test Set
Ventilation Baffle
91400-01 Shelf No. 2
Ventilation Baffle
91400-01 Shelf No. 1
91004-31
91455-01 Fuse Panel
Ventilation Baffle
91400-01 Shelf No. 3
Space
*Test Set
*Jackfield
Space
Ventilation Baffle
91400-01 Shelf No. 2
Ventilation Baffle
91400-01 Shelf No. 1
91004-32
91455-01 Fuse Panel
91400-01 Shelf No. 4
91400-01 Shelf No. 3
91400-01 Shelf No. 2
91400-01 Shelf No. 1
91004-33
Ventilation Baffle
91400-01 Shelf No. 3
Ventilation Baffle
91455-01 Fuse Panel
Blank Panel
Blank Panel
Blank Panel
Space
Ventilation Baffle
91400-01 Shelf No. 2
Ventilation Baffle
91400-01 Shelf No. 1
55
50
45
40
35
30
25
20
15
10
5
1

*Not included in standard assembly; order separately.

Figure 6-1. Standard Assemblies (Sheet 3 of 3)

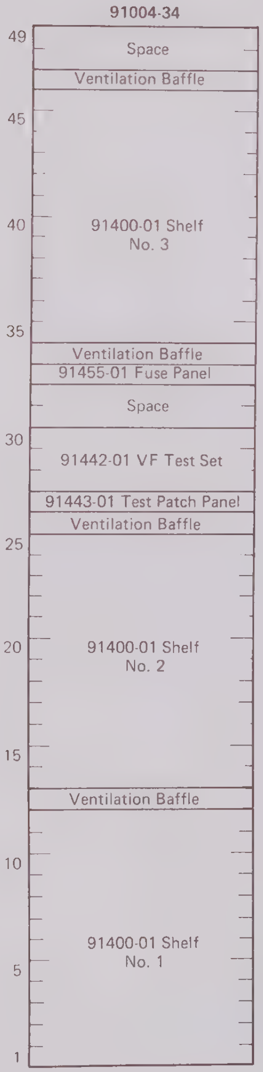

91004-34
49
Space
Ventilation Baffle
45
40
91400-01 Shelf No. 3
35
Ventilation Baffle
91455-01 Fuse Panel
Space
30
91442-01 VF Test Set
91443-01 Test Patch Panel
Ventilation Baffle
25
20
91400-01 Shelf No. 2
15
Ventilation Baffle
10
5
91400-01 Shelf No. 1
1

Figure A. Rack Assemblies

Ordering Number	Minimum Rack Height		24-Channel Digroups	Notes
91004-20	3.56 m	11′8″	12	1
-21	3.56 m	11′8″	10	
-22	3.50 m	11′6″	10	
-23	3.50 m	11′6″	10	
-30	2.74 m	9′	8	
-31	2.44 m	8′	6	
-32	2.44 m	8′	8	1
-33	2.44 m	8′	6	
-34	2.44 m	8′	6	

Figure B. Equipment Racks

Type No.	Height		Usable Mounting Spaces
Unequal-Flange Duct Type (Aluminum)			
31000-05	2.13 m	7′	43
04	2.44 m	8′	49
-03	2.64 m	8′8″	54
-02	2.74 m	9′	56
-01	3.50 m	11′6″	73
-06	3.56 m	11′8″	74
Self-Supporting Channel Type (Aluminum)			
31051-07	2.13 m	7′	44
-09	2.29 m	7′6″	47
-10	2.45 m	8′1/4″	51
-21	2.64 m	8′8″	54
13	2.74 m	9′	57
-14	2.74 m	9′	57
-23	2.90 m	9′6″	60
Overhead-Supported Channel Type (Aluminum)			
31052-02	2.44 m	8′	49
-05	2.74 m	9′	56
-14	3.50 m	11′6″	73
-15	3.56 m	11′8″	74

Figure C. Common Equipment: Equipped Shelves and Loose Sets of Plug-Ins

Ordering Number	Mode	Transmit Unit, Qty 1	Receive Unit, Qty 1	Quantity				
				91420-01 Alarm Control Unit	91424-01 Battery Filter Unit (Note 2)	91425-01 Power Supply Unit	91426-01 Syndes Unit	91400-01 Terminal Equipment Shelf
91004-01	1	91421-01	91431-01	1		1		1
-02	2	91422-01	91432-01	2		1	1	1
-03	3	91423-01	91433-01	2		1		1
-04								
-05								
06	1	91421-01	91431-01	1		1		
-07	2	91422-01	91432-01	2		1	1	
-08	3	91423-01	91433-01	2		1		
-09								
-10								
-11								
-12								

Notes:

1. 91004-20 and -32 Rack Assemblies. Because these configurations do not include ventilation baffles, heat buildup must be considered if the channel banks will be equipped mostly with DPO or FXS channel units. Refer to paragraphs 4.03 and 4.04.
2. 91424 Battery Filter Unit. This unit is optional and must be ordered separately, if required. Refer to paragraph 4.09.

7. ORDERING INFORMATION

7.01 GTE Lenkurt equipment items listed in figures 5-1 through 5-6 and figure 6-1 may be ordered by specifying the identifying numbers, including any applicable dash numbers and option codes, and the name or a brief description. Rack type and height also must be specified for the standard rack assemblies (91004-xx) in figure 6-1.

7.02 Upon receiving the order, GTE Lenkurt will provide an acknowledgment and a scheduled shipping date. An equipment list showing the applicable assemblies and individual equipment items will be included in the shipment.

GTE LENKURT

Company Headquarters and Manufacturing Facility
1105 County Road
San Carlos, California 94070
Phone 415–595-3000

Albuquerque Manufacturing Facility
One Camino de Lenkurt
Albuquerque, New Mexico 87123
Phone 505–296-0551

El Paso Manufacturing Facility
10727 Gateway West
El Paso, Texas 79935
Phone 915 -593 3400

District Sales Offices
1105 County Road
San Carlos, California 94070
Phone 415– 595 3000

120 West Eastman Street
Arlington Heights, Illinois 60004
Phone 312–398 6700

542 Haggard Street, Suite 510
Plano, Texas 75074
Phone 214–422 4305

3015 Williams Drive
Fairfax, Virginia 22031
Phone 703–698 1850

5780 Peachtree-Dunwoody Road, N.E.
Suite 145
Atlanta, Georgia 30342
Phone 404–256 3000

GTE International Sales Office
1105 County Road
San Carlos, California 94070
Phone 415–595-3000
Cable. GENTELINT

GTE Practices
Engineering—Plant Series
GTE LENKURT

Addendum 342—911—112
Issue 3, July 1981

9004A PCM Channel Bank — INSTALLATION AND MAINTENANCE

1. GENERAL

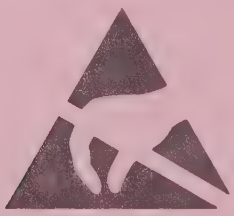
1.01 This Addendum to Issue 1 of Section 342-911-112 incorporates Addendum 2, revises Caution on ESDS devices, and adds two new test cords. The changes in this Addendum are indicated by revision arrows.

1.02 In ink or red pencil, make the changes described in Part 2 or write "See Addendum" in the margin adjacent to the change. Remove Addendum 2 and file this Addendum directly in front of Section 342-911-112, Issue 1.

2. CHANGES

▶● 2.01 Delete text added by paragraph 2.01 in Addendum 2 and insert the following NOTE after paragraph 2.01 in the GTEP:

NOTE: As the electronics industry uses lower power and higher density equipment packages, the components have become more susceptible to damage from electrostatic discharge. In such cases, GTE Lenkurt designs the equipment to minimize the possibility of failure resulting from electrostatic discharge. However, when electrostatic discharge sensitive (ESDS) components are used, the printed wiring boards are identified by coloring the board's front edge red. The boards and their shipping containers are also marked with the Electronic Industries Association (EIA) symbol (see below) for ESDS devices. For enclosed circuit boards, the case as well as the board is identified with the EIA symbol. You may wish to handle these boards according to your company procedures or by referring to Section 300-000-001.



The following list identifies ESDS units:

Channel units (All)
Receive units (91431, 91432, 91433)
Alarm control unit (91420) ◀

● 2.02 Page 1, add the following at the end of paragraph 2.04: "Mount the baffle on the rack so that it slopes up from the rear, directing the rising heated air out the grill at the front."

● 2.03 Page 7, paragraph 2.10, fourth line, change "088-56608-01" to "088-56608-xx."

● 2.04 Page 7, paragraph 2.11, replace the first two sentences with the following: "The breakouts from wiring harnesses 088-56608-01 through -04 are spaced for standard rack assemblies (Section 342-911-111) with a 91455 panel at the top of the rack and up to six channel banks. Wiring harness 088-56609-01 has breakouts for a 91455 panel near the middle of the rack and five channel banks."

● 2.05 Page 7, delete paragraphs 2.13, 2.13(a), and 2.13(b).

● 2.06 Pages 7 and 9, replace paragraph 2.14 with the following:

2.14 Field wirewrapping to the 0.025-inch square terminals on J14 and J29 is not recommended. For nonstandard rack configurations, wiring harness 088-56608-06, which has two connectors and 12 insulated wire leads, 24 AWG (0.50 mm) solid, 3.7 metres (12 feet) long, can be used to access the alarm circuits of one channel bank at J14 and J29. The -06 wiring harness is recommended for all modes. Wiring harness 088-56608-05, which has a single connector and nine wire leads for access to one 91420 unit, is recommended for mode 1 only.

● 2.07 Page 9, figure 2-5, add the following as a subparagraph in Note 1:

Wiring harnesses 088-56608-02, -03, and -04 have connectors for five, four, and three channel banks, respectively.

● 2.08 Page 9, figure 2-5, add the following note:

5. Maximum Load. The maximum continuous current through the fuse panel should not exceed 55 amperes. This is the total of the input currents at TB1-3 and -4.

● 2.09 Page 9, add the following at the end of paragraph 2.18: "With the connectors fully engaged, turn the top and bottom screws in one or two full threads; then tighten them alternately so that the plug connector is not pulled out of alignment with the receptacle connector."

▶● 2.10 Page 13, figure 3-1, add the following data on new test cords in the appropriate column.

2	796B Test Cord (Optional)	—	Two each two-conductor cables 3.0 metres (10 feet) long. Has 12-pin printed circuit plug on one end and two miniature tip-ring-sleeve telephone plugs on the other end. Used for T-R and T1-R1 carrier access to channel unit.
2	796C Test Cord (Optional)	—	Two-conductor cable 3.0 metres (10-feet) long. Has 12-pin printed circuit plug on one end and a 310-type tip-ring-sleeve plug on the other end. Used for E&M carrier access to channel unit.

◀

● 2.11 Page 21, figure 4-6, step 5b, replace first sentence with: "Insert terminating plug in EXT OSC jack on 91442." In step 5d, delete "or cord."

● 2.12 Page 37, after paragraph 6.04, add the following new paragraphs:

6.04a Voice frequency transmission and signaling/supervision (but not pulsing) can be checked by replacing the channel unit at either or both banks with a 91445 Signaling Path Test Set. Use of the 91445 is described below.

(a) For vf tests, patch the 91445 to a 91442 VF Test Set or a 91443 Test Patch Panel with a 796A Patch Cord.

(b) The vf transmit/receive levels at the TEST receptacle connector on the 91445 are −16/+7 dBm, four-wire. If the 91442 VF Test Set is being used, set both the XMT ATTEN and RCV ATTEN on the 91442 at 1.5 dB.

(c) The toggle switches and LED's on the 91445 control and monitor the state of the A and B signaling channels. For example, if the switch at one bank is set to XMT A, the RCV A indicator at the other bank should light.

(d) If the 91445 is being used in an end-to-end test with a channel unit that normally receives the same signaling information on the A and B channels (as most trunk channel units do), the toggle switches on the 91445 should always be operated simultaneously to the same position. Otherwise, the signaling state decoded by the channel unit will alternate every 750 μs.

● 2.13 Page 37, replace paragraph 6.07(b) with the following:

(b) +12V to GND: 11.8 to 12.6
(c) −12V to GND: 11.4 to 12.6

GTE Practices
Engineering—Plant Series
GTE LENKURT

9004A PCM Channel Bank - INSTALLATION AND MAINTENANCE

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1. GENERAL

1.01 This Section covers installation and maintenance of the 9004A PCM Channel Bank and includes procedures for acceptance testing, routine maintenance, and troubleshooting. Associated publications are listed in figure 1-1.

Figure 1-1. Associated Publications

GTE Practices Section	Title
342-911-111	9004A PCM Channel Bank
342-911-114	91402 2W E&M and 91404 4W E&M Channel Units
342-911-115	91407 4W Tandem, 91408 FXO, and 91409 FXS Channel Units
342-911-116	91401 Four-Wire Channel Unit
342-911-117	91403 DPO and 91405 DPT Channel Units

2. INSTALLATION

Receiving

2.01 When the equipment is received, inspect it carefully for damage. Claims for damage incurred in shipment should be made directly to the transportation company in accordance with their instructions. Save the shipping cartons until installation is completed.

Mounting

See add

2.02 The 91400 Terminal Equipment Shelf (channel bank shelf) occupies 12 mounting spaces on a standard 483-mm (19-inch) equipment rack. Figure 2-1 shows front and rear views of the shelf; figure 2-2 gives overall and mounting dimensions.

2.03 The 91455 Fuse and Alarm Panel distributes power from the 48-volt office battery to six channel banks and associated equipment through nine alarm-type fuses. Channel bank audible, visual, and EAX alarm circuits can be consolidated on the 91455 panel for connection to the office alarm equipment. The panel occupies one rack mounting space; see figure 2-3 for features and dimensions.

2.04 Refer to Section 342-911-111 for engineering considerations about locating the equipment in the office, avoiding rack cable congestion, and the possible need for a one-space ventilation baffle above the channel bank on the rack.

[illegible]

Cable Equalizers

2.05 As shipped from the factory, the 91400 shelf is equipped with 6-dB pads for two DS1 transmit lines and a 2-dB pad for a DS1C transmit line. The pads are soldered to standoff terminals at the upper left-hand corner of the shelf at the rear; see figure 2-4. When required for the longer lengths of office cabling, equalizers are supplied loose for field installation. Remove the pad and solder the equalizer in place, component side out. The DS1 equalizer is identified by the part number 087-56705-01 or -02; the DS1C equalizer is 087-56705-03 or -04.

Figure 2-1. 91400 Terminal Equipment Shelf, Front and Rear Views (Sheet 1 of 2)

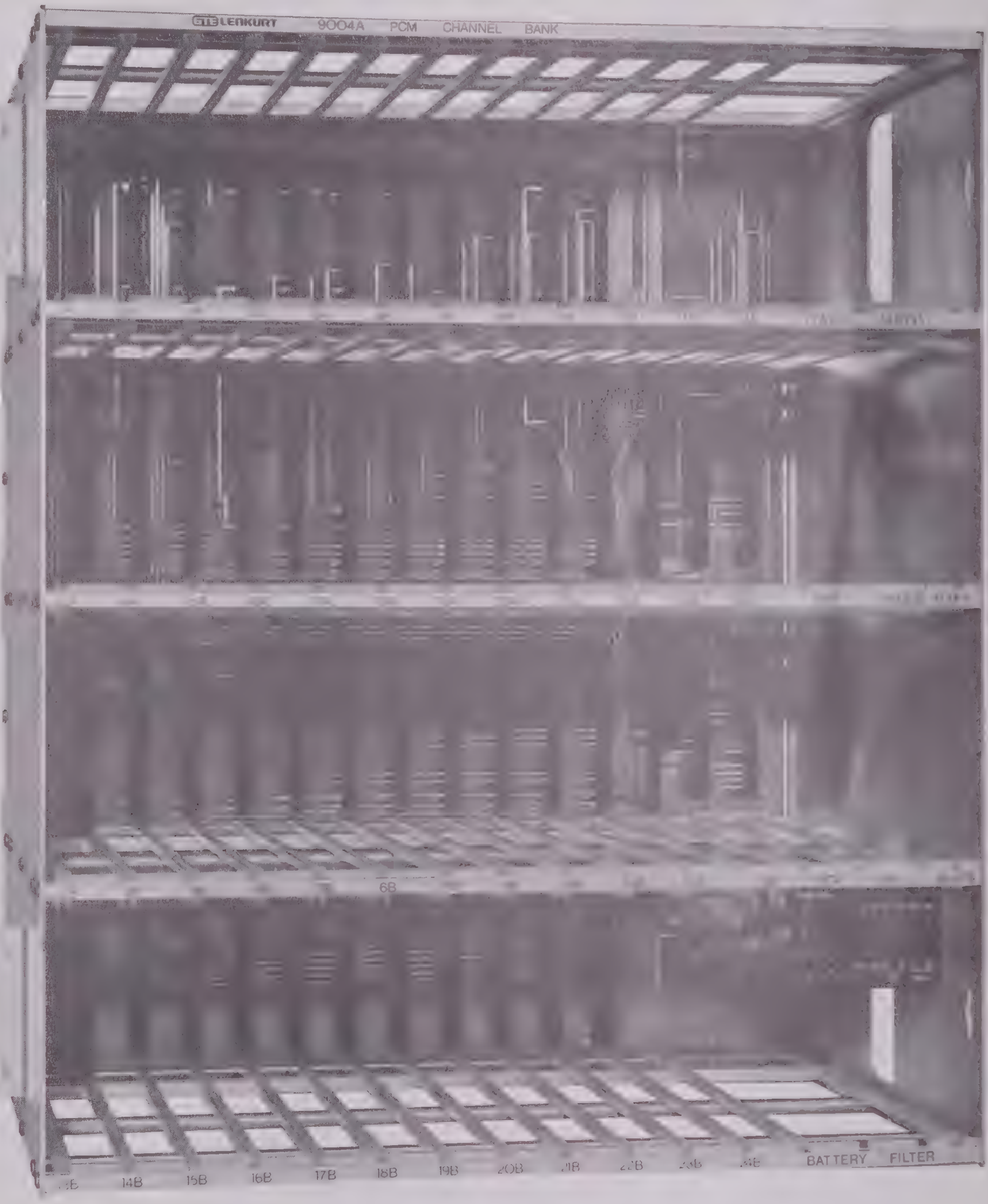

GTE LENKURT
9004A PCM CHANNEL BANK
6B
14B
15B
16B
17B
18B
19B
20B
BATTERY
FILTER

Figure 2-1. 91400 Terminal Equipment Shelf, Front and Rear Views (Sheet 2 of 2)

6 BB

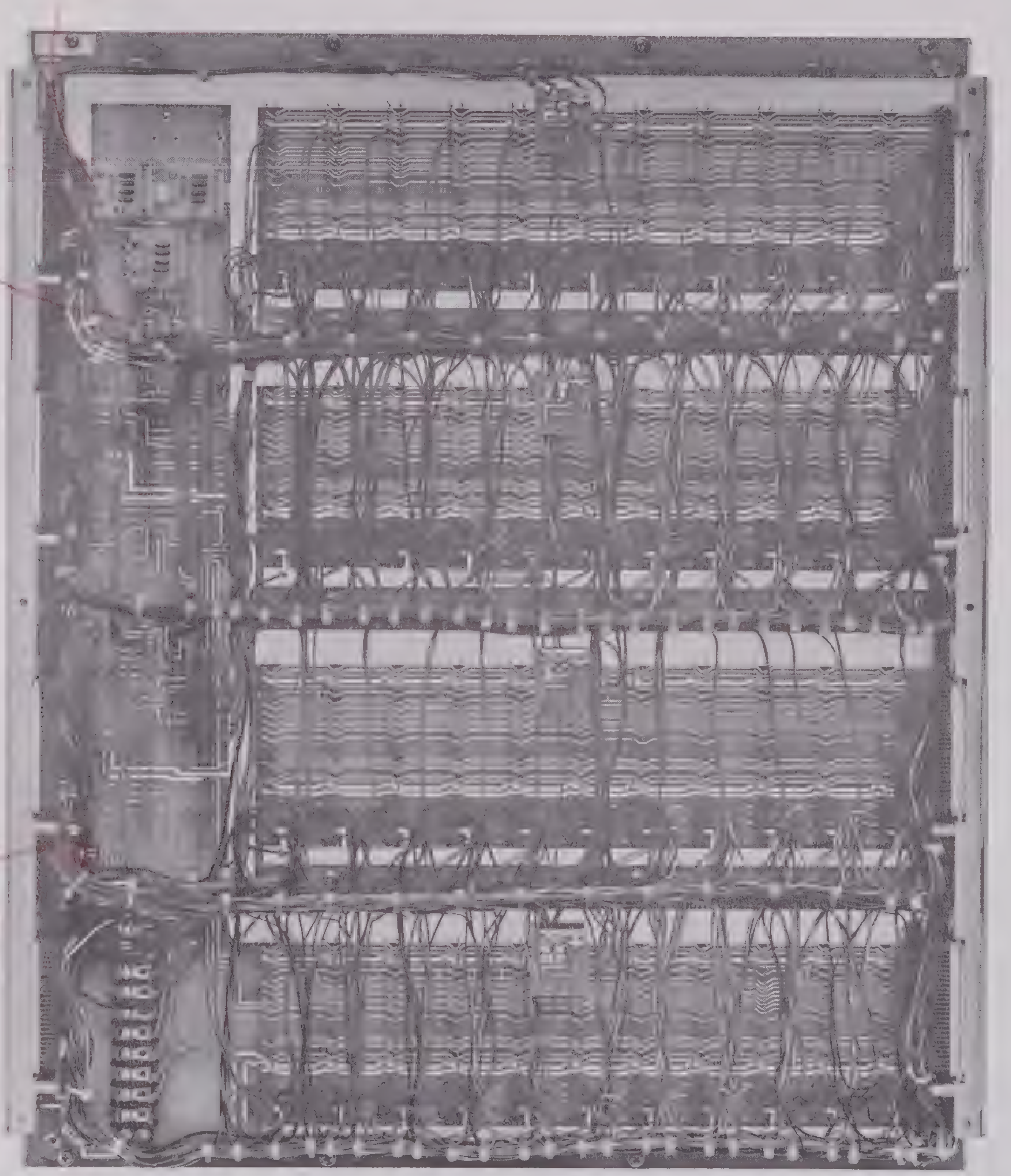


Figure 2-2. 91400 Terminal Equipment Shelf, Overall and Mounting Dimensions

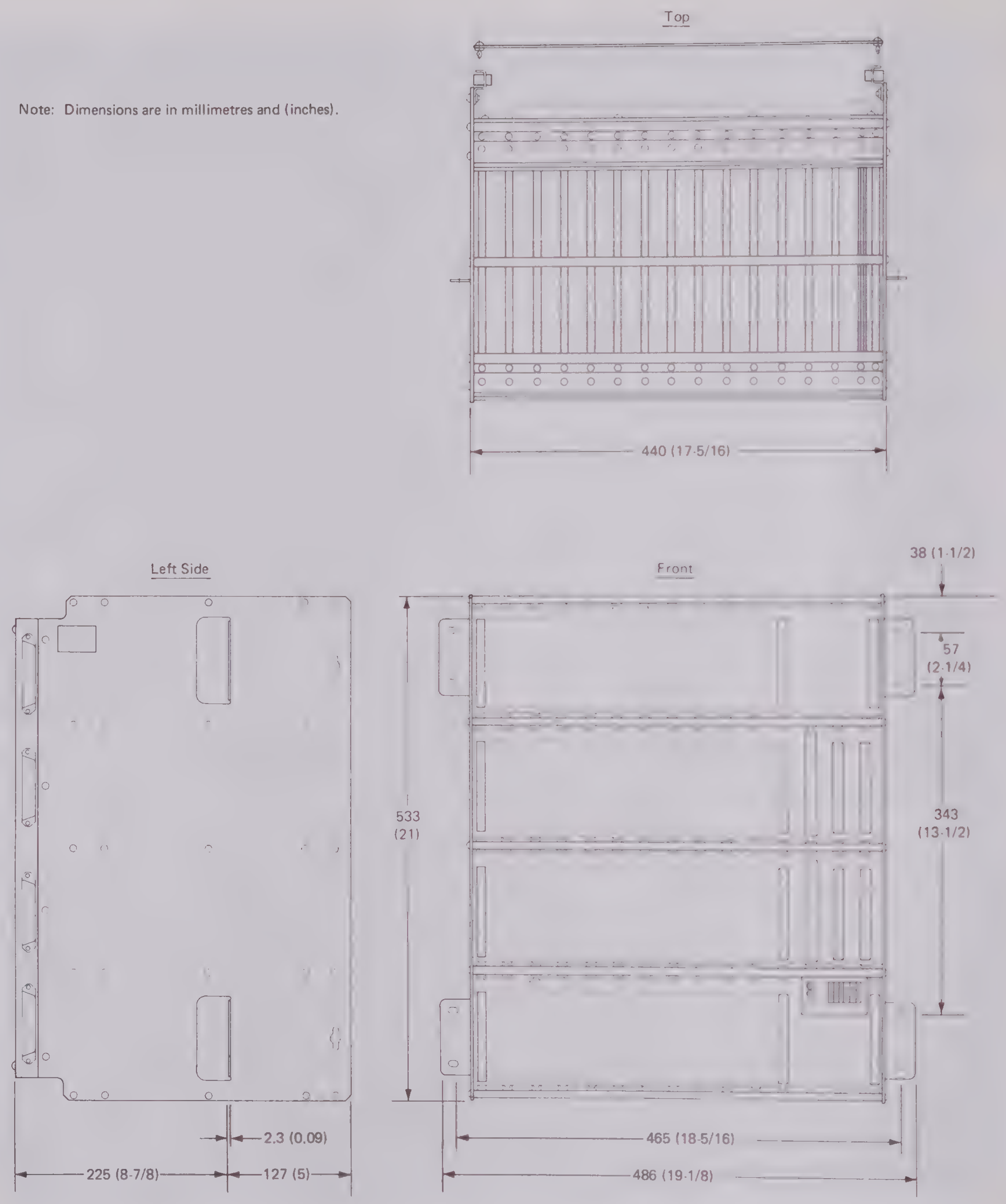
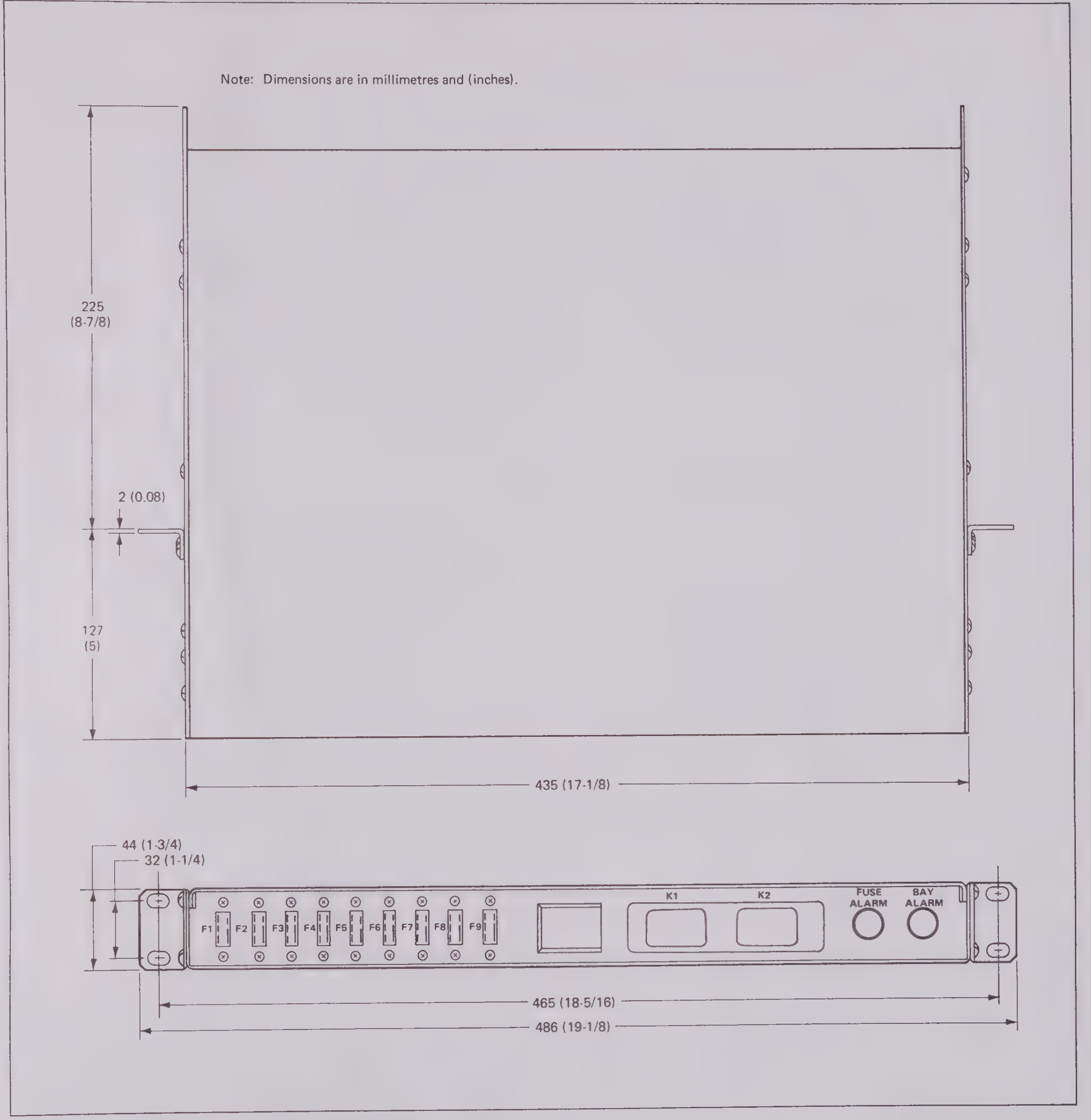

Note: Dimensions are in millimetres and (inches).
Top
440 (17-5/16)
Left Side
Front
38 (1-1/2)
57 (2-1/4)
343 (13-1/2)
533 (21)
2.3 (0.09)
225 (8-7/8)
127 (5)
465 (18-5/16)
486 (19-1/8)

Figure 2-3. 91455 Fuse and Alarm Panel, Overall and Mounting Dimensions


Note: Dimensions are in millimetres and (inches).
225 (8-7/8)
2 (0.08)
127 (5)
435 (17-1/8)
44 (1-3/4)
32 (1-1/4)
F1
F2
F3
F4
F5
F6
F7
F8
F9
K1
K2
FUSE ALARM
BAY ALARM
465 (18-5/16)
486 (19-1/8)

Office Wiring

2.06 Figure 2-4 shows the terminations of external wiring and cables on the 91400 shelf. Figure 2-5 shows the internal circuits of the 91455 Fuse and Alarm Panel and the interconnections to the channel bank alarm circuits. Refer to the engineering considerations in Section 342-911-111 for recommended wire and cable types and gauges.

2.07 Power. If the installation includes the 91455 Fuse and Alarm Panel, wire office battery and ground to TB1 on the panel as shown in figure 2-5. The clamp-type terminals accept wire sizes up to 6 AWG (4 mm). Place the battery or ground lead (round cross section) against the concave bottom of the terminal cavity and the U-link jumper (rectangular cross section), if used, against the set screw above. Alternatives to the arrangement in figure 2-5 are described below.

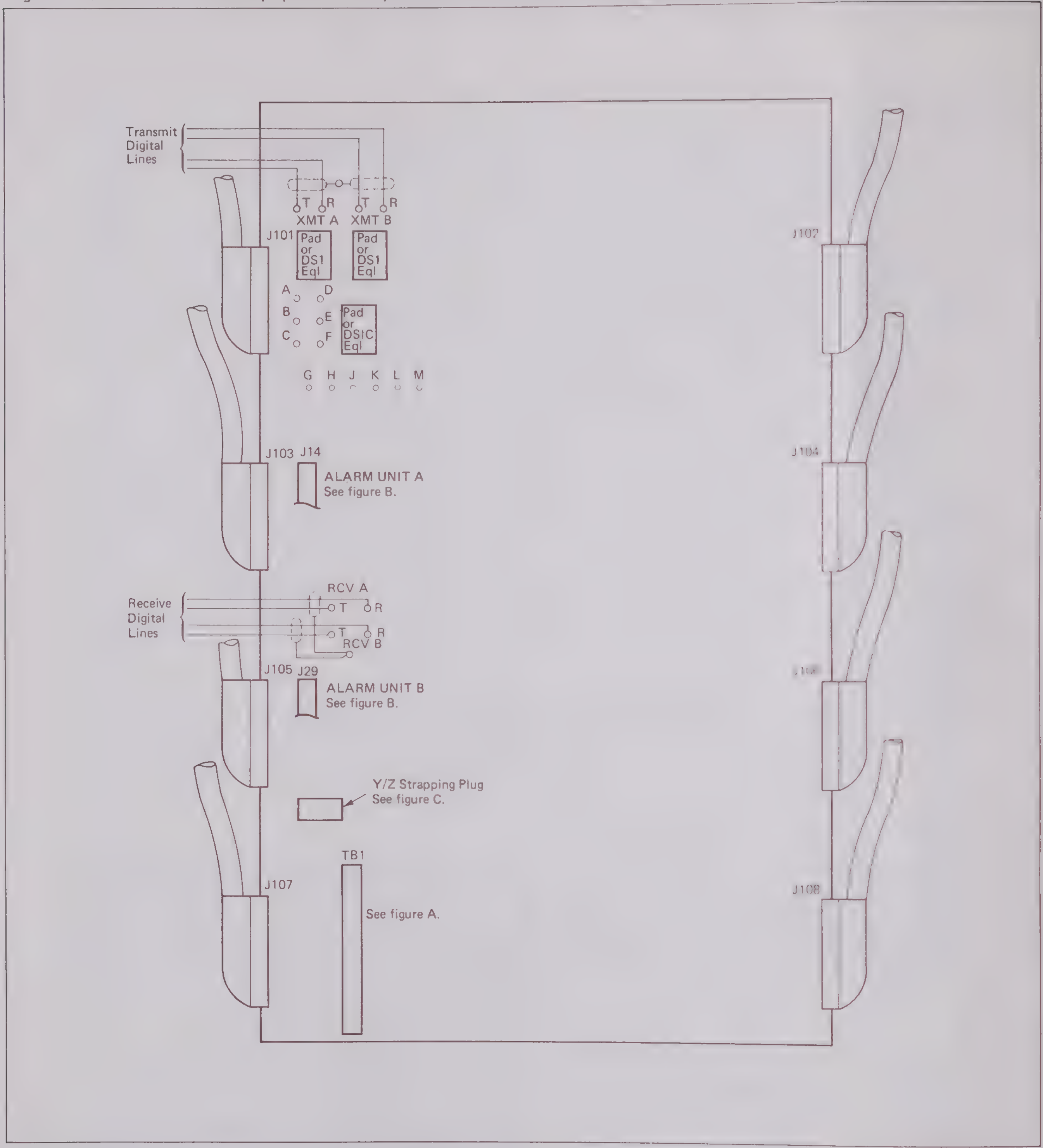
(a) If separate A and B power distribution is used, remove the jumper between TB1-3 and -4.

(b) If separate battery ground and rack ground connections are required, remove the jumper between TB1-1 and -2.

NOTE: Grounding should be in accordance with Section 795-805-073.

2.08 Office battery is distributed to the channel banks and auxiliary equipment from TB2 on the 91455

Figure 2-4. 91400 Terminal Equipment Shelf, External Connections and Strapping (Sheet 1 of 2)


Transmit Digital Lines
T
R
XMT A
T
R
XMT B
J101
Pad or DS1 Eql
Pad or DS1 Eql
A
D
B
E
C
F
Pad or DSIC Eql
G H J K L M
J102
J103
J14
ALARM UNIT A
See figure B.
J104
Receive Digital Lines
RCV A
T
R
T
R
RCV B
J105
J29
ALARM UNIT B
See figure B.
Y/Z Strapping Plug
See figure C.
TB1
J107
See figure A.
J108

panel. The clamp-type terminals on TB2 accept wire sizes up to 12 AWG (2 mm). When installation work is complete, install a 7.5-ampere GMT-type fuse (pn 175-28996-12, black-white code) in the applicable fuseholder; fuses F1-F6 are for channel banks 1-6.

2.09 Wire office battery and ground, and the 20-Hz ringing supply if required, to TB1 on the 91400 shelf as shown in figure 2-4A. Alternatives are described below.

(a) If separate battery ground and rack ground connections are required, remove the electrical clip (pn 137-49295-01) between TB1-1 and -2.

(b) If an external talk battery filter is used, remove the electrical clip between TB1-3 and -4 and wire the talk battery lead to TB1-4.

NOTE: If the channel bank is equipped with DPO or FXS channel units, it must also have a 91424 Battery Filter Unit. The talk battery and 20-Hz ringing supplies are distributed to the channel units through the 91424 unit.

Rel contact

2.10 Alarms. Three form C contacts of the system alarm relay in the 91420 Alarm Control Units appear on receptacle connectors J14 (unit A) and J29

Figure 2-4. 91400 Terminal Equipment Shelf, External Connections and Strapping (Sheet 2 of 2)

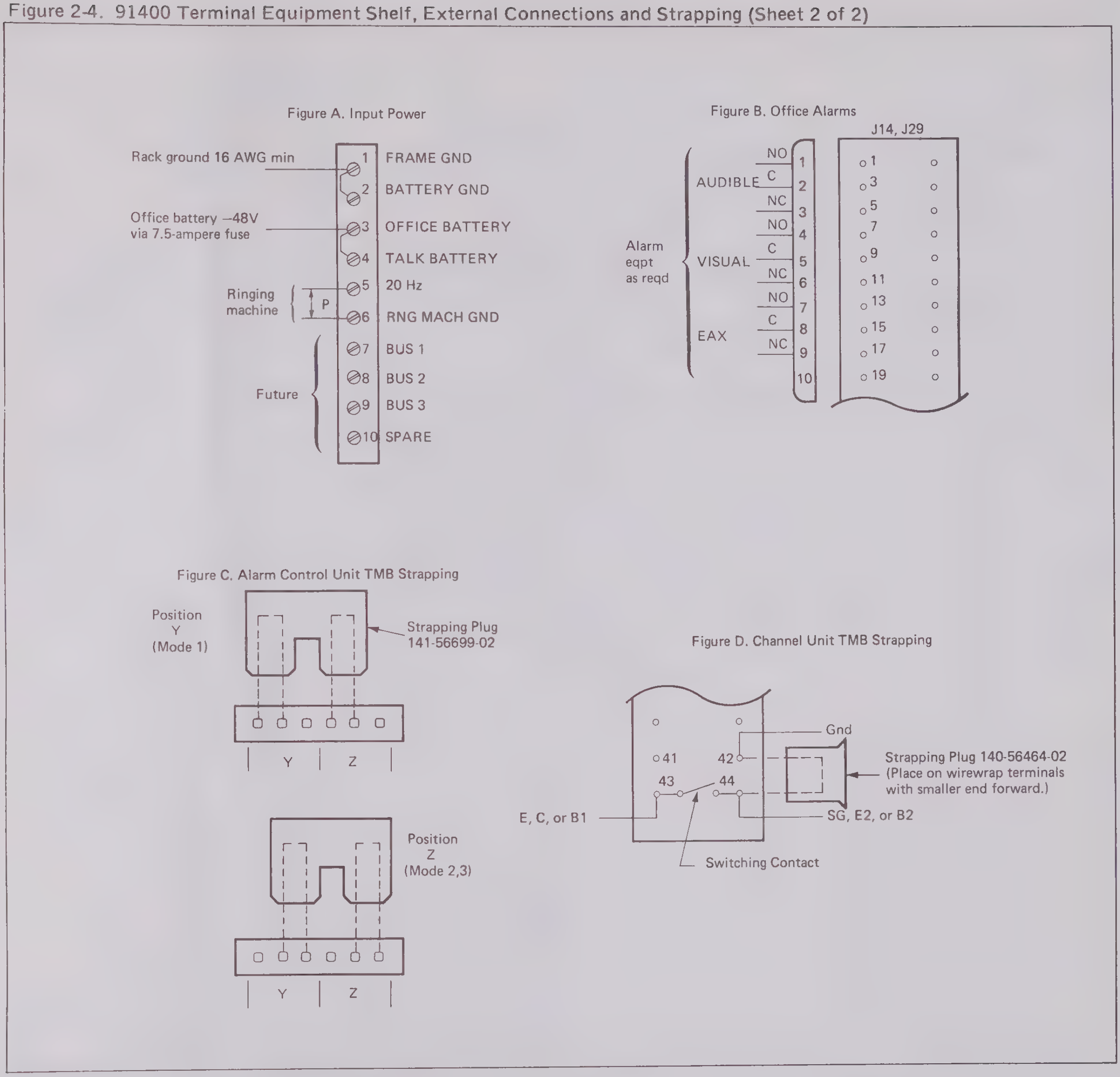


Figure A. Input Power

Figure B. Office Alarms

Figure C. Alarm Control Unit TMB Strapping

Figure D. Channel Unit TMB Strapping

Rack ground 16 AWG min
1 FRAME GND
2 BATTERY GND
Office battery –48V via 7.5-ampere fuse
3 OFFICE BATTERY
4 TALK BATTERY
Ringing machine
P
5 20 Hz
6 RNG MACH GND
Future
7 BUS 1
8 BUS 2
9 BUS 3
10 SPARE
J14, J29
Alarm eqpt as reqd
AUDIBLE
VISUAL
EAX
NO
C
NC
1
2
3
4
5
6
7
8
9
10
11
13
15
17
19
Position Y (Mode 1)
Strapping Plug 141-56699-02
Y
Z
Position Z (Mode 2,3)
Gnd
41
42
43
44
Strapping Plug 140-56464-02 (Place on wirewrap terminals with smaller end forward.)
E, C, or B1
SG, E2, or B2
Switching Contact

(unit B) of the 91400 shelf. If the rack assembly has a 91455 Fuse and Alarm Panel, the system alarm circuits can be extended to TB3 on the panel with a wiring harness (pn 088-56608-01 or 088-56609-01) as shown in figure 2-5. The harness has 10-contact female connectors that plug onto the left-hand vertical row of wirewrap terminals on J14 and J29. Contacts 1 through 10 mate with odd-numbered terminals 1 through 19.

See add'l

2.11 The breakouts from wiring harness 088-56608-01 are spaced for six channel banks on an 11'8" rack with the 91455 panel at the top of the rack. Wiring harness 088-56609-01 is for a rack with five channel banks and a 91455 panel near the middle of the rack. If a rack assembly has fewer channel bank positions, the excess harness may be cut off. Audible and visual alarm leads, which are multipled between connectors, should be insulated and tied back at the cutoff; unused EAX alarm leads should be tied back at each end.

CAUTION: Install the wiring harness and connect office wiring before you apply power to the 91455 panel.

2.12 Wirewrap the 24-AWG (0.5-mm) wiring harness leads to the 0.045-inch square terminals on TB3 of the 91455 panel as shown in figure 2-5. After the harness has been installed, office alarm leads should be wirewrapped on the same side of TB3. Unplug relay K2 temporarily to silence the office alarms.

See add'l

2.13 If the rack assembly does not include a 91455 Fuse and Alarm Panel, ~~or if only a few alarm leads~~ are required, ~~you can fabricate~~ a wiring harness from 24- or 26-AWG (0.5- or 0.4-mm) wire ~~and the parts~~ listed below.

(a) Connector, female; GTE Lenkurt pn 140-54174-06 (Molex pn 09-50-7101).

(b) Contact, electrical; GTE Lenkurt pn 140-54175-01 (Molex pn 08-56-0108), nine contacts maximum per connector. A crimping tool (Molex pn HTR-2445-A, or equivalent) is required.

2.14 As an ~~alternative to the~~ connectors, alarm leads ~~can be~~ wired directly to the terminals of J14 and

See add'l

Figure 2-5. 91455 Fuse and Alarm Panel, Circuit Diagram (Sheet 1 of 2)

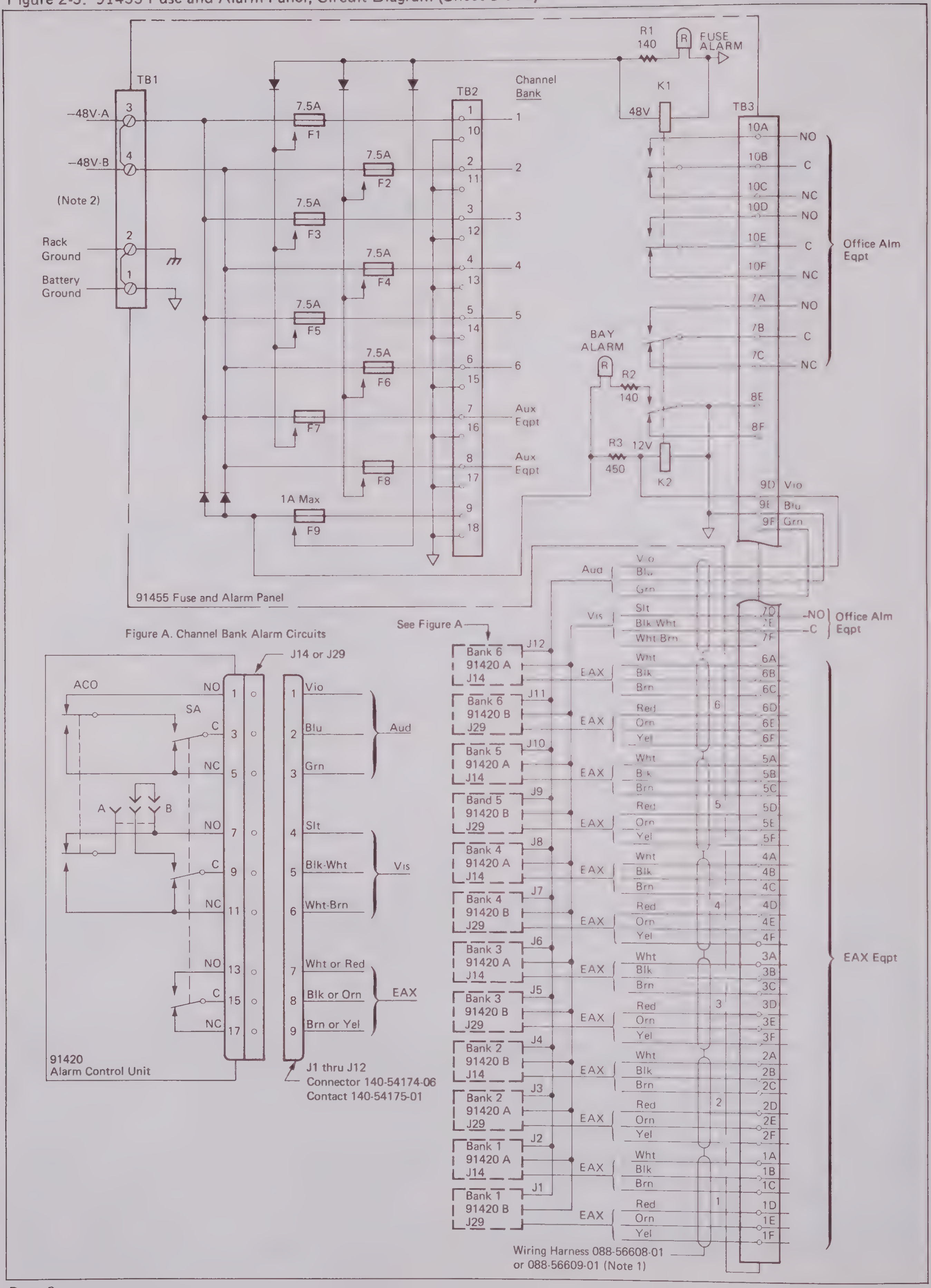
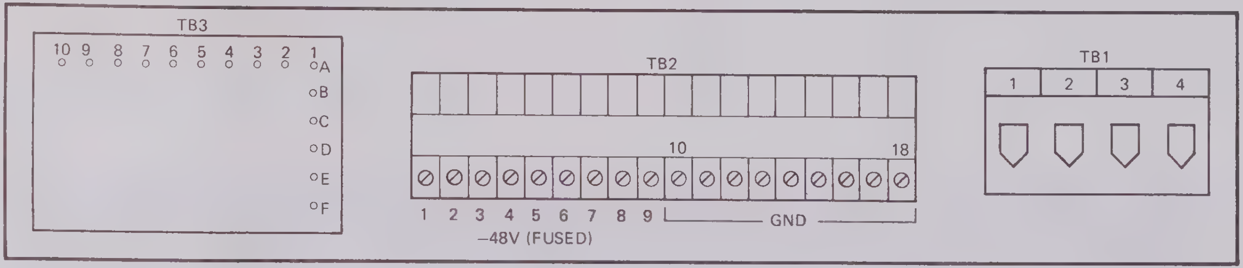

TB1
–48V-A
3
–48V-B
4
(Note 2)
Rack Ground
2
Battery Ground
1
7.5A
F1
7.5A
F2
7.5A
F3
7.5A
F4
7.5A
F5
7.5A
F6
F7
F8
1A Max
F9
TB2
Channel Bank
1
10
2
11
3
12
4
13
5
14
6
15
7
16
8
17
9
18
Aux Eqpt
Aux Eqpt
R1
140
FUSE ALARM
R
K1
48V
TB3
10A
10B
10C
10D
10E
10F
7A
7B
7C
8E
8F
NO
C
NC
NO
C
NC
NO
C
NC
Office Alm Eqpt
BAY ALARM
R
R2
140
R3
450
12V
K2
9D
9E
9F
Vio
Blu
Grn
91455 Fuse and Alarm Panel
Aud
Vio
Blu
Grn
Vis
Slt
Blk Wht
Wht Brn
7D
7E
7F
NO
C
Office Alm Eqpt
See Figure A
Bank 6 91420 A J14
J12
Bank 6 91420 B J29
J11
Bank 5 91420 A J14
J10
Band 5 91420 B J29
J9
Bank 4 91420 A J14
J8
Bank 4 91420 B J29
J7
Bank 3 91420 A J14
J6
Bank 3 91420 B J29
J5
Bank 2 91420 B J14
J4
Bank 2 91420 A J29
J3
Bank 1 91420 A J14
J2
Bank 1 91420 B J29
J1
EAX
Wht
Blk
Brn
Red
Orn
Yel
6
5
4
3
2
1
6A
6B
6C
6D
6E
6F
5A
5B
5C
5D
5E
5F
4A
4B
4C
4D
4E
4F
3A
3B
3C
3D
3E
3F
2A
2B
2C
2D
2E
2F
1A
1B
1C
1D
1E
1F
EAX Eqpt
Wiring Harness 088-56608-01 or 088-56609-01 (Note 1)
Figure A. Channel Bank Alarm Circuits
J14 or J29
ACO
SA
A
B
NO
C
NC
NO
C
NC
NO
C
NC
1
3
5
7
9
11
13
15
17
1
2
3
4
5
6
7
8
9
Vio
Blu
Grn
Slt
Blk-Wht
Wht-Brn
Wht or Red
Blk or Orn
Brn or Yel
Aud
Vis
EAX
91420 Alarm Control Unit
J1 thru J12
Connector 140-54174-06
Contact 140-54175-01

Figure 2-5. 91455 Fuse and Alarm Panel, Circuit Diagram (Sheet 2 of 2)

Figure B. Rear View of Panel Showing Terminal Boards



Notes:

1. Wiring Harnesses. Wiring harness 088-56608-01 has 12 connectors (J1 through J12) for six channel banks with the 91455 panel at the top of the rack above bank 6.

   Wiring harness 088-56609-01 has 10 connectors (J1 through J10) for five channel banks with the 91455 panel near the middle of the rack above bank 2.

2. Terminal Board TB1. If separate A and B power distribution is used, remove the U-link jumper (pn 137-56660-03) between TB1-3 and TB1-4.

   If separate battery ground and rack ground connections are required, remove the U-link jumper between TB1-1 and TB1-2.

3. Relays. K1 and K2 are plug-in relays. They are shown in the condition of normal operation.

4. Fuses. GMT alarm-type fuses F1 through F9 are not furnished with the 91455 panel and must be ordered separately. The standard size for the 9004A channel bank (F1 through F6) is 7-1/2 amperes. The maximum size for F9 is 1 ampere; this limit is imposed by the rating of the diodes that isolate the A and B supplies.

Fuse Rating Amperes	Color	GTE Lenkurt Stock No. 175-28996
0.18	Yellow	-04
1/4	Violet	-05
1/2	Red	-09
3/4	Brown	-06
1	Gray	-01
1-1/3	White	-02
2	Orange	-03
3	Blue	-07
5	Green	-10
7-1/2	Black-White	-12

See addl

2.07
2.08

J29. However, working space around J14 and J29 is minimal ~~and you must be very~~ careful to avoid breaking the 0.025-inch square ~~terminals. The wirewrapping~~ tool bit is smaller ~~than the~~ one used for the 0.045-inch ~~square termi-nals on~~ the 91455 panel. Maximum wire size is 26 AWG (0.4 mm).

2.15 Digital Lines. If the channel bank is to operate in mode 3, connect the DS1 cable pairs of digroup A to XMT A and RCV A and the DS1 cable pairs of digroup B to XMT B and RCV B as shown in figure 2-4. These are 0.045-inch square wirewrap terminals. For channel bank mode 1 or 2, connect the DS1C cable pairs to XMT A and RCV A.

2.16 To complete the digital transmit circuit through the pad or equalizer to XMT A, you must install four straps on wirewrap terminals A through M, as follows.

(a) Mode 1 or 2: strap B-C, E-F, H-J, and L-M.

(b) Mode 3: strap A-B, D-E, G-H, and K-L.

2.17 VF and Signaling/Supervisory Circuits. The office interface with the channel unit vf and signaling/supervisory circuits is made at 50-pin receptacle connectors J101-J104 (digroup A) and J105-J108 (digroup B) as shown in figure 2-4. Connections are made through GTE Lenkurt cable assemblies 163-10315-xx or 163-10316-xx or through locally-fabricated cable assemblies. For information on connector pin assignments and cable color codes, refer to the engineering considerations in Section 342-911-111.

See addl 2.04

2.18 The shelf-mounted receptacle connector and the mating plug connector on the cable assembly are ~~secured by two 4-40~~ shoulder screws, pn 125-56426-01, that are about 1/8 inch ~~longer than~~ the screws ordinarily supplied by the connector manufacturer. ~~Sixteen~~ of the longer screws are included in the bag of loose parts ~~fur-~~nished with the 91400 shelf.

Terminal Equipment Shelf Strapping

2.19 Alarm Control Unit TMB. The channel bank has one 91420 Alarm Control Unit in mode 1 (unit A) and two in mode 2 or 3 (units A and B). To configure the TMB buses between the alarm control units and the channel units, install the double-pole Y/Z strapping plug (figure 2-4C) according to the channel bank mode as follows.

(a) Mode 1: position Y

(b) Mode 2 or 3: position Z

2.20 Channel Unit TMB. On each channel unit receptacle connector (figure 2-4D), a single-pole strapping plug is installed on the bottom two wirewrap terminals in the right-hand row, connecting ground from pin 42 to 44. When the channel unit is unplugged, switching contacts on the connector close the ground on pin 44 to a C lead or E lead on pin 43, busying the trunk toward the office.

2.21 In certain channel unit applications, pin 44 is assigned a signaling/supervisory function and should not be grounded, or pin 43 should not be grounded when the channel unit is unplugged. In these cases, move the strapping plug onto the bottom two terminals in the left-hand row (41 and 43); this is a nonfunctional storage or parking position. Refer to the GTEP Section applicable to the particular channel unit type as listed in figure 1-1.

NOTE: The bag of loose parts furnished with the 91400 shelf includes a spare strapping plug, pn 140-56464-02.

Common Equipment Strapping

2.22 The alarm control unit has one strapping option and the transmit unit has four. Each option uses a single-pole strapping plug, pn 141-56699-01.

NOTE: The bag of loose parts furnished with the 91400 shelf includes an extraction tool, pn 020-56788-01, for the strapping plugs on the common equipment and channel units.

2.23 Alarm Control Unit. The system alarm relay of the 91420 unit has three form C dry contacts dedicated to office alarm circuits as shown in figure 2-5. In a system alarm condition, operation of the ACO relay disables the audible alarm, but has no effect on the EAX alarm. The visual alarm may be disabled or not according to the position of the A/B strapping plug as follows.

(a) Positon A: ACO disables visual alarm

(b) Position B: ACO does not affect visual alarm

2.24 Transmit Unit. Strap the transmit unit for the applicable option listed in figure 2-6. The A/B, C/D, E/F, and G/H strapping plugs are at the front edge of the unit. (The A/B strapping has no function on the 91422 or 91423 transmit unit.)

Figure 2-6. Transmit Unit Strapping Options

Option		Strapping Plug Position
F-bit source (91421 only)	External	A
	Internal	*B
Signaling	Normal	*C
	No signaling (eight-bit encoding)	D
Transmit clock source	Internal clock	*E, G
	Looped receive clock	F, G
	External clock	E, H
* Factory strapping		

Channel Unit Strapping

2.25 Before you plug the channel units into the shelf, install or verify strapping in accordance with the instructions in the channel unit GTEP Section listed in figure 1-1. In addition to vf and signaling/supervisory strapping options, channel units have strappable attenuators and network buildout (NBO) capacitors as described below.

(a) All channel units have six-section transmit and receive attenuators with values of 0.1, 0.2, 0.4, 0.8, 1.6, and 3.2 dB. This provides an adjustment range of 0 to 6.3 dB in 0.1-dB steps. A strapping plug must be inserted in the IN or OUT position of each section. See figure 2-7.

(b) Four-wire channel units have tandem transmit and receive attenuators with three or four possible values (including 0 dB). A strapping plug must be inserted in one of the three or four positions.

(c) Two-wire channel units have six NBO capacitors for compensating capacitance on the two-wire drop between 0 and 0.126 μF (126 nF) in 0.002-μF steps. Capacitance is added by inserting the strapping plug in the position adjacent to the value marked in nF: 2, 4, 8, 16, 32, and 64. Positions marked "0" are for parking the strapping plug when the capacitance is not required. See figure 2-7.

Unit Installation or Removal

2.26 Plug-in units on each of the four shelf levels are secured at the bottom by a plastic locking bar. To install or remove a unit, slide the locking bar to the right. Some common equipment units have an extractor lever to facilitate disengaging the unit from the shelf receptacle connector. On the channel units, the faceplate serves as a handle for this purpose.

Channel Assignment Label

2.27 Information about channel assignments should be recorded on the label (pn 123-91400-01) illustrated in figure 2-8. The label is adhesive-backed white vinyl with a matte writing surface.

NOTE: To measure transmission levels with the 91232 or 91442 test set, channel unit transmit and receive attenuator settings must be known. The right-hand column of the channel assignment label provides a convenient place to record this data.

2.28 The label attaches to either of two brackets as shown in figure 2-8. One bracket (pn 020-56730-01) mounts in the keyhole slots on the left or right side plate of the shelf. The other bracket, used when the shelf is mounted on the rear of an unequal-flange duct type rack, attaches to the left or right vertical channel of the rack.

3. MAINTENANCE

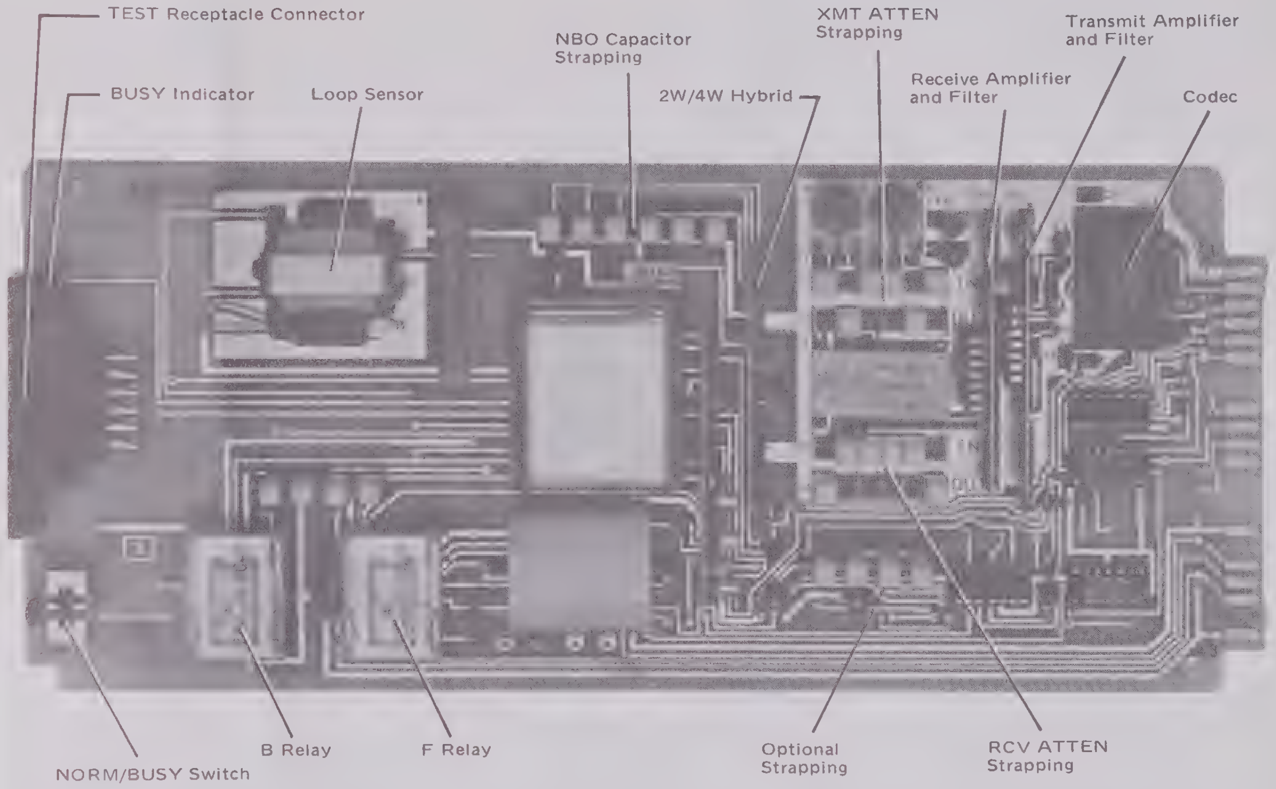
3.01 Part 3 of this Section is background information applicable to the test procedures in Parts 4 and 5 and the troubleshooting procedures in Part 6.

Test Equipment

3.02 For complete testing capability, the test equipment items listed in figure 3-1 are required. Another item may be substituted if it has suitable accuracy and fully performs the required test functions.

3.03 In the channel performance tests, test equipment is patched to miniature telephone-type jacks on the 91442 VF Test Set or the 91232 Test and Alignment Set. The connection is made through the tip and ring of the jack; the sleeve is grounded. A transformer in the test set provides impedance matching and isolation between the unbalanced 600-ohm test equipment and the balanced 600-ohm or 900-ohm vf channel circuits. Levels can be read directly in dBm and dBrnc without applying a correction factor to the meter reading.

Figure 2-7. Typical Channel Unit Features



3.04 Meters are operated in the terminating mode with the 91442 test set and in the bridging mode with the 91232 test set. (The bridging mode is specified for crosstalk measurements with the 91442 test set.)

Controls and Indicators

3.05 The functions of controls and indicators on the channel bank are described in figure 3-2.

Test Record

3.06 An important part of testing is keeping an accurate record of results. Records of prior performance can be very helpful in troubleshooting. Also, the historical test data can be used to evaluate long-term system performance.

3.07 The form shown in figure 3-3 is suggested as a means of recording data from the initial tests and the subsequent periodic routine tests.

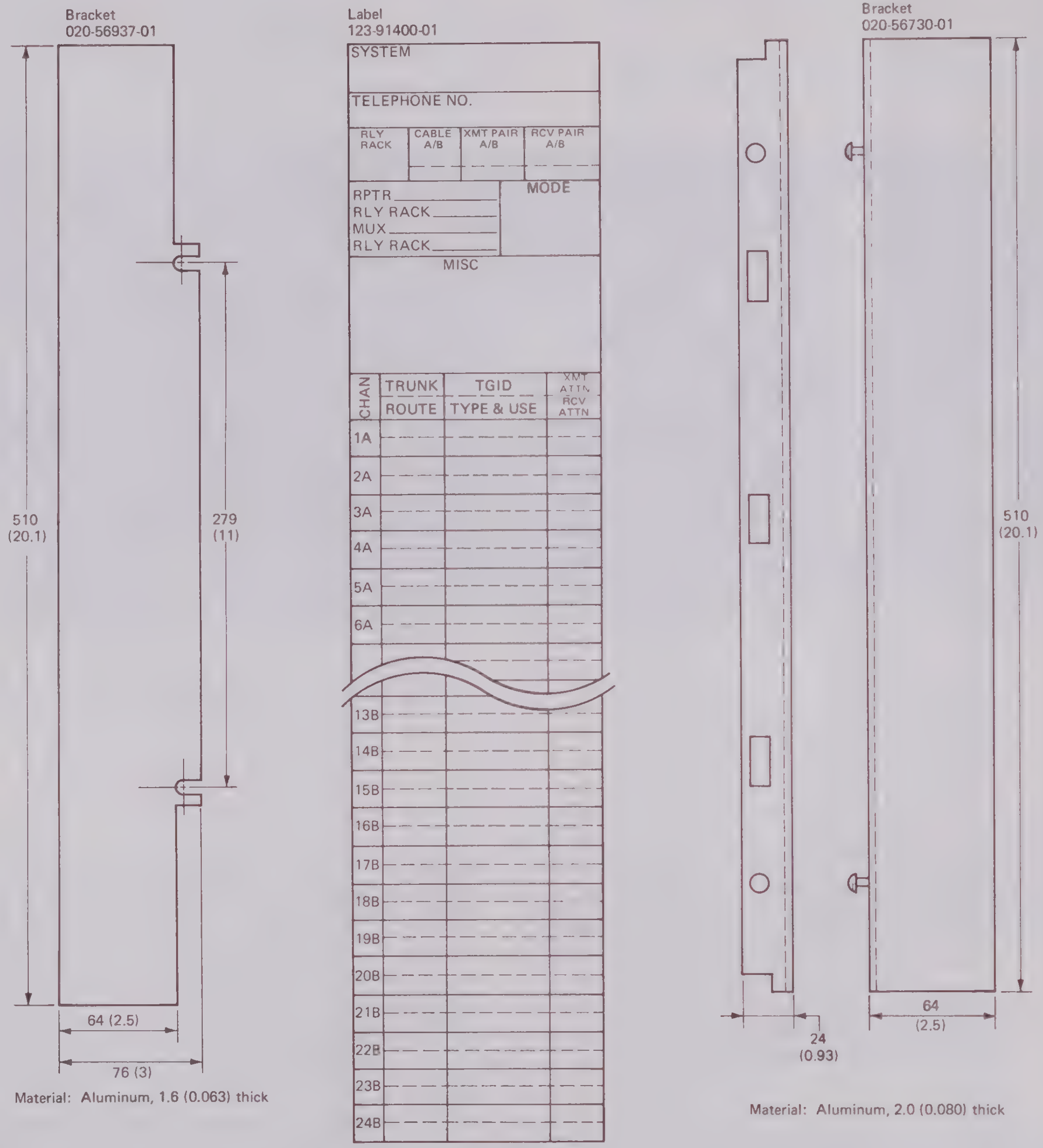
Factory Repair Service

3.08 Field repair of defective units is not recommended. Equipment failures should be corrected by replacing the defective unit with a spare. Defective units should be tagged, with the defect identified where possible, and sent to GTE Lenkurt, San Carlos, attention: Factory Service Department, where most items can be repaired within 14 calendar days after equipment is received at the factory. If spares are not available and down time is critical, this service can be accelerated or temporary replacement units can be furnished while the defective unit is being repaired (GTE Lenkurt's CARE Program: Customer Accommodation Restoration Equipment). In any such emergency, contact a GTE Lenkurt Factory Service Representative: 415 595-3000 (day or night). For equipment out of warranty, there is a charge only for the repair and test of the defective unit. If a temporary CARE unit is required, there is an additional handling charge. Information on defective units may be furnished informally either by mail or telephone but should include a purchase order number as well as ship-to and bill-to addresses. Details on GTE Lenkurt's Factory Repair and CARE Services may be obtained from any GTE Lenkurt Sales Representative. For further information, GTE companies may refer to GTE Practice Section 992-600-003, "Repair and Return, GTE Lenkurt Equipment." Other GTE Lenkurt customers may obtain copies of the brochure "Factory Repair Service" (0-2631) from any GTE Lenkurt sales office.

Performance Tests

3.09 Part 4 of this Section has four channel performance tests using the 91442 VF Test Set and four equivalent tests using the 91232 Test and Alignment Set. The first of the four tests is done with the channel bank looped and does not depend on having an operational transmission facility between terminals. The other three are end-to-end tests.

Figure 2-8. Channel Assignment Label


Bracket
020-56937-01
510
(20.1)
279
(11)
64 (2.5)
76 (3)
Label
123-91400-01
SYSTEM
TELEPHONE NO.
RLY RACK
CABLE A/B
XMT PAIR A/B
RCV PAIR A/B
RPTR
RLY RACK
MUX
RLY RACK
MODE
MISC
CHAN
TRUNK
ROUTE
TGID
TYPE & USE
XMT ATTN
RCV ATTN
1A
2A
3A
4A
5A
6A
13B
14B
15B
16B
17B
18B
19B
20B
21B
22B
23B
24B
Bracket
020-56730-01
510
(20.1)
64
(2.5)
24
(0.93)

Material: Aluminum, 1.6 (0.063) thick

Material: Adhesive-backed vinyl

Material: Aluminum, 2.0 (0.080) thick

Note: Dimensions are in millimetres and (inches).

Figure 3-1. List of Test Equipment

Qty per Site	Test Equipment (GTE Lenkurt unless otherwise specified)	Notes	Description and Use
1	91232 Test and Alignment Set	1	Provides a vf measuring circuit used in conjunction with external meters; supplies 1025-Hz test tone at 0 or -16 dBm. (The digital section of the 91232 is for testing 9002A/B channel banks and is not applicable to 9004A.)
1	91442 VF Test Set	1	Portable or rack-mounting test set for measuring transmission level, noise, distortion, and crosstalk on an external meter such as a TTS-37B Noise Measuring Set; contains a 1020-Hz test-tone generator; connects to the channel unit TEST connector through a 796A Patch Cord; direction of test can be reversed without altering test setup.
1	91443 Test Patch Panel	1	Interface between the channel unit TEST connector and external test equipment, including the 91232 Test and Alignment Set; one rack mounting space.
1	91445 Signaling Path Test Set		Four-wire channel unit modified for vf and signaling tests on any channel; transmit/receive levels are a fixed —16/+7 dBm at the TEST connector; A and B signaling channels have toggle switches for transmit control and LED's for receive indications.
1	26600 Signaling Test Set		Sends signaling pulses at selected rate and percent break; receives signaling pulses and measures percent break.
1	Northeast Electronics TTS-37B Noise Measuring Set		Noise and level measuring test set with switch-type weighting networks and hold coil.
1	Northeast Electronics TTS-58A-CN Impulse Noise Counter		Counts number of pulses exceeding a selected level over a selected time interval.
1	Hewlett-Packard 204C Oscillator		For optional frequency response tests, 200 to 3400 Hz at 0 dBm.
1	Simpson 260-6 Volt-Ohm-Milliammeter		General-purpose multimeter with 20,000-ohms/volt sensitivity.
2	725A Cord		Two-conductor cable 3.6 metres (12 feet) long wired between tip and sleeve of two 310-type tip-ring-sleeve telephone plugs; used to supply —48V power to 26600, TTS-37B, TTS-58A, and 91442.
2	796A Patch Cord		Twelve-conductor cable with a double-sided printed circuit plug connector on each end; connects TEST receptacle connector on channel unit to CHANNEL UNIT receptacle connector on 91442 VF Test Set or 91443 Test Patch Panel; also usable for restoration patching between certain channel units. —01 1.8 metres (6 feet) long —02 3.6 metres (12 feet) long
2	6000A-01 600-Ohm Terminating Plug		Miniature telephone plug with a 600-ohm resistor between tip and ring.
2	6100B-02 Cord		Shielded two-conductor cable 3.0 metres (10 feet) long with a miniature tip-ring-sleeve telephone plug on one end and a twin banana plug on the other end; equivalent to 6000B-02.
2	6100C-02 Cord		Shielded two-conductor cable 3.0 metres (10 feet) long with a miniature tip-ring-sleeve telephone plug on each end; equivalent to 6000C-02.
2	6100D-02 Cord		Shielded two-conductor cable 3.0 metres (10 feet) long with a 310-type tip-ring-sleeve telephone plug on one end and a miniature tip-ring-sleeve telephone plug on the other end; equivalent to 6000D-02.
2	141-54484-01 Open Plug		Dummy (plastic) miniature telephone plug.

Notes: see add 2.10

1. Channel Performance Tests. The 91442 VF Test Set is recommended for channel performance tests. The combination of a 91232 Test and Alignment Set and a 91443 Test Patch Panel is an alternative.

3.10 Figure 3-4 lists the test procedures in Part 4 and a system alarm restoral test procedure in Part 5 and notes their applicability to channel bank installation, routine maintenance, and unit replacement. Testing is to be done in both directions of transmission.

3.11 For routine maintenance with the channel bank in service, the vf level, idle noise, distortion, and impulse noise are measured on each channel, in turn. The recommended interval for routine maintenance is 2 years.

3.12 Because of the many signaling circuit variations, the procedures for measuring dial pulse signaling distortion are in the GTEP Sections of individual channel unit types (figure 1-1).

Restoration Patching

3.13 In a system failure, service may be restored on a small number of high-priority circuits by patching them to lower-priority channels in an adjacent working system. Connect a 796A Patch Cord between the TEST receptacle connector on the channel units at each end of the system. The channel units must be the same type and you may have to change strapping to coordinate levels and options. As shown in figure 4-1, the wiring in the 796A cord is "frogged" so that the carrier side of each channel unit is connected to the drop side of the other channel unit.

Figure 3-2. Channel Bank Controls and Indicators

Equipment	Name	Description	Function
Alarm control unit	LOOP	Locking pushbutton and green LED	If the SYS ALM lamp and ACO indicator are lighted, depressing the LOOP pushbutton does the following: lights the LOOP indicator; loops the 48-channel (mode 1) or 24-channel (mode 2 or 3) digital signal from the transmit unit to the receive unit; transmits an all-1's signal to the digital line.
	ACO	Nonlocking pushbutton and white-red LED	If the SYS ALM lamp is lighted, depressing the ACO pushbutton operates the alarm cutoff relay and lights the ACO indicator. Relay operation disables the audible alarm and visual alarm (strapping option) circuits to the office but does not affect the EAX alarm circuit. The alarm cutoff relay releases automatically when the system alarm condition clears.
	LOC	Red LED	Indicates loss of receive signal or an out-of-frame condition. LOC has a 40-ms integration time, whereas FR SCH on the receive unit is instantaneous.
	REM	Yellow LED	Indicates the remote channel bank is in a system alarm condition, initiated by a local alarm or maintained by an operated TMB HOLD pushbutton.
	TMB HOLD	Locking pushbutton and white-red LED	With the SYS ALM lamp and ACO indicator lighted, depressing the TMB HOLD pushbutton forces bit 2 of the transmit channel words to 0 and maintains the system alarm condition. The TMB HOLD indicator lights while the pushbutton is depressed. If the digital line signal is looped back, REM lights if the signal is received and framed upon; otherwise LOC lights.
	SYS ALM	Yellow lamp	Indicates a system alarm condition, which is initiated by a power, local, or remote alarm. With the alarm cutoff relay operated, a system alarm is maintained by an operated LOOP or TMB HOLD pushbutton.
Channel unit	BUSY	Red LED	Lights in response to an off-hook condition in the transmit or receive direction.
	NORM/BUSY	Slide switch	When the switch is set to BUSY position, the channel is made busy toward the drop and toward the far end according to channel unit type and strapping options.
Power supply unit	ALM	Red LED	Indicates failure of the +5, —5, +12, or —12 volt power supply outputs.
Receive unit	FR SCH	Red LED	Indicates loss of receive signal or an out-of-frame condition. The mode 2 and 3 receive units have separate LED's for the A and B digroups. The FR SCH indication is instantaneous, whereas the LOC indication on the alarm control unit has a 40-ms integration time.
	ON/OFF	Slide switch	If the alarm control unit is in loop condition, setting the switch to ON position injects a digital test tone (1-kHz, 0-dBm0) in each channel of both digroups (mode 1) or the applicable digroup (mode 2 or 3).
	TONE	Green LED	Indicates injection of digital test tone. The mode 2 and 3 receive units have separate LED's for the A and B digroups.
Syndes unit	TEST	Nonlocking pushbutton	If one or both alarm control units is in the loop condition, momentarily depressing the TEST pushbutton loops the DS1C signal and unloops the digroup(s) for 300 milliseconds.
	PASS	Green LED	When the TEST pushbutton is depressed, the PASS indicator lights if the syndes unit and the receive unit (both digroups) reframe to the looped DS1C signal; the indicator remains lighted until the TEST pushbutton is released.
	FAIL	Red LED	When the TEST pushbutton is depressed, the FAIL indicator lights if the syndes unit or receive unit (either or both digroups) does not reframe to the looped DS1C signal; the indicator remains lighted until the TEST pushbutton is released.
	LOCAL	Red LED	Lights when the syndes unit is out of frame for longer than 200 ms.
	REMOTE	Yellow LED	Lights when the remote alarm bit in the receive DS1C signal indicates an alarm condition at the distant terminal (M4=0).
Terminal equipment shelf	FUSE ALARM A and B	Red LED's	Indicates a blown SIG or TALK fuse, A or B. Both LED's light if the PS fuse blows.

Figure 3-3. Sample Test Record Form

Test	Notes	Requirements			Channel No. and Reading at Initial Test	Routine Test Period ______Months					
						Date By	Date By	Date By	Date By	Date By	Date By
Vf level	1										
Idle noise	2	23 dBrnc0 maximum									
Distortion	3	TRANSMIT ATTENUATOR on 91232 Test Set	0 dB	57 or 47 dBrnc max							
			—20 dB	37 or 27 dBrnc max							
			—34 dB	29 or 19 dBrnc max							
		SEND LEVEL on 91442 Test Set	0 dB	57 dBrnc max							
			—10 dB	47 dBrnc max							
			—20 dB	37 dBrnc max							
			—30 dB	27 dBrnc max							
			—40 dB	23 dBrnc max							
Dial pulse signaling distortion	4	Refer to applicable channel unit GTEP Section listed in figure 1-1.									

Notes:

1. VF Level. Initial applicable block to indicate that vf level has been checked on all channels.
2. Idle Noise. Test all channels; record data for two.
   If the measurement is made using the 91232 test set, the meter readings are in dBrnc. To convert to dBrnc0, algebraically subtract the transmission level at the point of test. For example, 23 dBrnc0 is 30 dBrnc at a +7 TLP or 20 dBrnc at a —3 TLP.
   If the measurement is made using the 91442 test set, the meter readings are in dBrnc0.
3. Distortion. Test all channels; record data for one. If the measurements are made using the 91232 test set, the lower distortion level listed above is for the 80-dBrnc reference.
4. Dial Pulse Signaling Distortion. Test all channels; record data for two.

Figure 3-4. List of Performance Tests

Channel Bank Mode	Procedure			Recommended (x)						
		Figure Using				Unit Replacement (Note 5)				
	Name	91442 Test Set	91232 Test Set	Instal-lation	Routine Maint (Note 4)	Transmit Unit	Receive Unit	Alarm Unit	Syndes Unit	Channel Unit (Note 3)
Looped	Vf level	4-6	4-11	x			x		x	
	Idle noise	4-6	4-11	x		x	x		x	
	Distortion	4-6	4-11	x		x	x		x	
End-to-end (Note 1)	Vf level	4-7	4-12		x					x
	Idle noise	4-7	4-12		x					x
	Distortion	4-7	4-12		x					x
	Impulse noise	4-7	4-12	x	x					x
	Frequency response	4-8	4-13	x						x
	System alarm restoral (Note 2)	5-1		x				x		
	Dial pulse signaling distortion	See applicable Section listed in figure 1-1.		x						x
	Crosstalk (Note 6)	4-9	4-14							

1. System Configuration. The end-to-end procedures in this Section are specifically for systems between 9004A channel banks. However, if the equipment at one end is not 9004A, end-to-end operation should be satisfactory if the channel bank at each end meets the looped test requirements.
2. System Alarm Restoral. The process by which the channel banks at each end of a system restore from an alarm condition is referred to as "simultaneous restoral" or " coordinated restoral."
3. Channel Unit Replacement. Strap the channel unit and set the vf attenuators before testing.
4. Routine Maintenance. The recommended interval for routine maintenance is 2 years. As part of the routine, a listening test should be made to verify absence of noise, crosstalk, etc.
5. Common Equipment. If you replace a common equipment unit, testing may be postponed until the system can be removed from service conveniently.
6. Crosstalk. This is an optional test used mainly for troubleshooting.

4. CHANNEL PERFORMANCE TESTS

4.01 The 91442 VF Test Set is recommended for channel performance testing. However, the 91232 Test and Alignment Set used in 9002A/B channel bank maintenance is a suitable alternative. A 91443 Test Patch Panel is required with the 91232 test set. With either test set, an external level/noise meter and vf signal generator (for frequency response) are required.

4.02 Vf transmit and receive signal paths of two-wire and four-wire channel units and the interface with the test sets are illustrated in figure 4-1. The 6.3-dB transmit/receive precision attenuators are shown strapped for 4.5/3.0 dB two-wire or 1.5/1.5 dB four-wire, and the four-wire tandem attenuators are strapped for 0 dB. This factory strapping results in standard transmit/receive levels at the TEST receptacle connector of 0/—3 dBm two-wire and —16/+7 dBm four-wire.

NOTE: In the 796A Patch Cord (figure 4-1), there is a transposition in each of the six pairs of wires. This enables the 796A to be used for restoration patching between the TEST connectors on certain channel units.

Test Descriptions

4.03 Procedures in Part 4 include measurement of vf level, idle noise, distortion, impulse noise, frequency response, and crosstalk. Channel units are tested in pairs on an end-to-end or loopback basis; each direction is tested, in turn.

4.04 VF Level. Vf drop level is measured at the receive channel unit with a 1-kHz analog test tone applied to the transmit channel unit. In loopback testing, the level of a digital test tone is measured also. The digital test tone is a coded pcm signal, 1 kHz at 0 dBm0, generated and inserted within the receive unit of the local channel bank. Levels are coordinated with the vf drop equipment by strapping the channel unit transmit and receive precision attenuators; there are no variable controls for field level adjustment.

NOTE: The frequencies of the analog test tone supplied by the 91232 and 91442 test sets are 1025 Hz and 1020 Hz, respectively. The digital test-tone frequency is 1000 Hz.

4.05 The tolerance on channel unit vf levels is much tighter than the accuracy of many commonly-used level meters (typically, ±0.5 dB). Therefore, the accuracy of the particular meter used must be considered in evaluating the channel performance test results.

4.06 Idle Noise. Idle noise is measured at the receive channel unit output with the transmit channel unit input terminated. The specification is 23 dBrnc0 maximum.

4.07 Distortion. A 1-kHz analog test tone is applied to the transmit channel unit input and the level is measured at the receive channel unit output. The level measuring circuit includes a 1-kHz band elimination filter so that the meter indicates harmonic distortion of 1 kHz plus quantizing distortion products.

4.08 Distortion is measured at several transmit levels to check codec linearity. The number of transmit levels is three from the 91232 test set and five from the 91442 test set. In the end-to-end channel performance test, if the test set is 91232 at one channel bank and 91442 at the other, the meter readings at the receive channel bank should be as specified in the procedure applicable to the test set at the transmit channel bank.

4.09 Impulse Noise. The transmit channel unit input is terminated (a holding tone is not required) and the receive channel unit output is connected to an impulse noise counter. Impulses that exceed a threshold level are tallied over a 5-minute period. Impulse noise is usually measured on an end-to-end basis only.

4.10 If the test is performed on an in-service system, normal supervision and random dialing may be present on the other channels, but continuous dial pulsing is not allowed. The repeatered line should be essentially error-free to avoid having any contribution to the reading made by impulse noise generated in the line.

4.11 Channel Frequency Response. Usually, channel frequency response is measured on an end-to-end basis only. The specification for a four-wire channel is 0 to —3 dB at 200 Hz and 3400 Hz relative to 1000 Hz. If the channel unit at either or both ends is a two-wire type, the specification at 200 Hz is 0 to —5 dB.

4.12 Channel Crosstalk. As an optional end-to-end test, mainly for troubleshooting, crosstalk into the channel under test is measured from the channel that precedes and the channel that follows in the sampling sequence. The specification is 25 dBrnc0 maximum.

NOTE: In the 9002A and 9002B channel banks, crosstalk usually originates in the transmit encoder, which is common to all channels. However, this crosstalk source is not applicable to the 9004A channel bank, which has individual channel codecs.

Conditioning Channels for Test

4.13 End-to-End Testing. When a channel is idle, as shown by dark BUSY indicators, the channel is appropriated for end-to-end testing by setting the NORM/BUSY switch to BUSY on the channel unit at each end. This busies the local switching equipment to prevent intrusion and lights the BUSY indicator. For certain applications, the effect of the NORM/BUSY switch is modified by channel unit strapping options; refer to figure 4-2.

NOTE: The NORM/BUSY switch on the 91405 DPT Channel Unit must be in NORM position for end-to-end testing.

4.14 For end-to-end pulsing tests, the NORM/BUSY switch is set to BUSY to appropriate the channel. After a test setup with the signaling test set has been arranged, the switch is returned to NORM position to enable pulsing.

4.15 Loop Testing. Looping the channel bank produces the following changes from normal end-to-end operation to allow testing from the vf input of one channel to the vf output of another channel via the common equipment and digital loopback.

(a) Channels are linked in pairs with a 12-channel offset: 1 and 13, 2 and 14, 3 and 15, etc.

(b) Vf transmission is enabled and signaling is disabled.

(c) The TMB function of the channel bank is activated; this busies the local switching equipment and lights the channel unit BUSY indicators; refer to figure 4-3.

4.16 91405 DPT Channel Unit. As shown in figure 4-4A, ground through pins 7-8 of the TEST receptacle connector produces logic 1 at the signaling circuit "Test" input to enable normal P relay operation. Some special considerations related to this feature are discussed below.

Figure 4-1. Channel Unit VF Levels

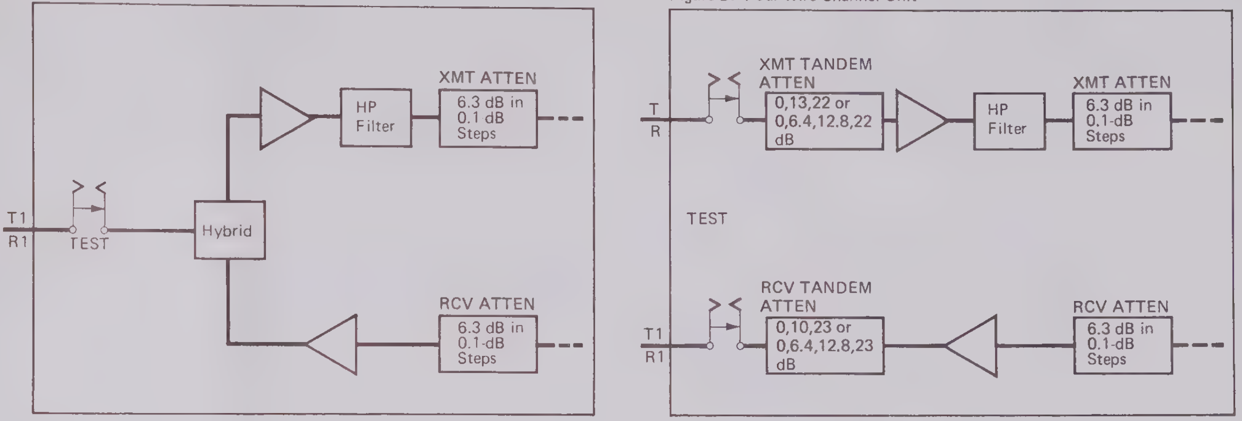


Figure A. Two-Wire Channel Unit

Figure B. Four-Wire Channel Unit

XMT ATTEN
HP Filter
6.3 dB in 0.1 dB Steps
T1
R1
TEST
Hybrid
RCV ATTEN
6.3 dB in 0.1-dB Steps
XMT TANDEM ATTEN
T
R
0,13,22 or 0,6.4,12.8,22 dB
HP Filter
XMT ATTEN
6.3 dB in 0.1-dB Steps
TEST
RCV TANDEM ATTEN
T1
R1
0,10,23 or 0,6.4,12.8,23 dB
RCV ATTEN
6.3 dB in 0.1-dB Steps

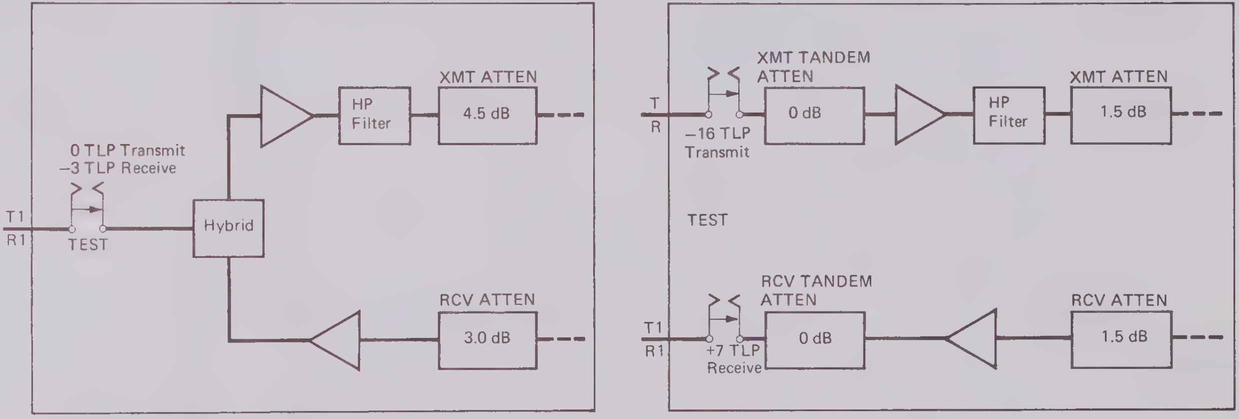
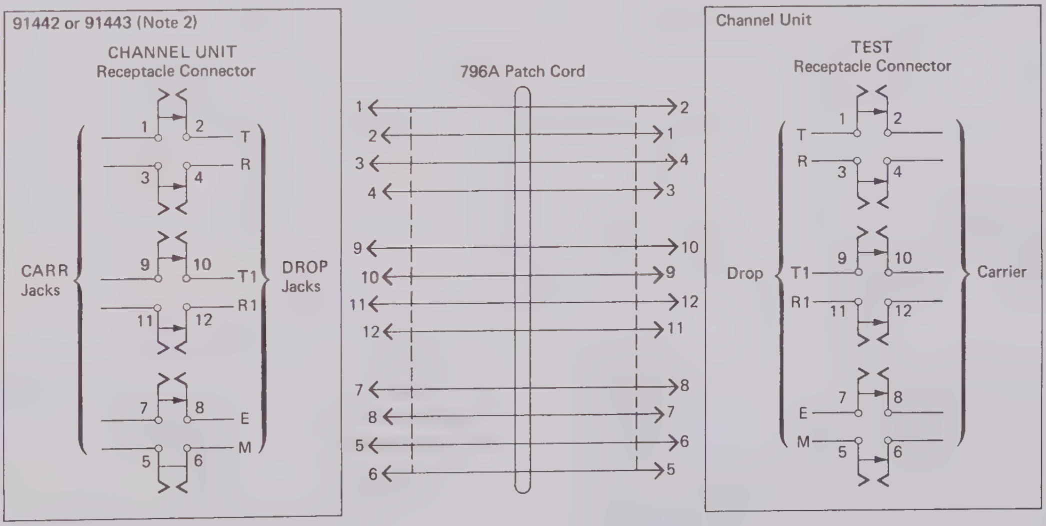


Figure C. Two-Wire Channel Unit Strapped for 0/−3 TLP

Figure D. Four-Wire Channel Unit Strapped for −16/+7 TLP

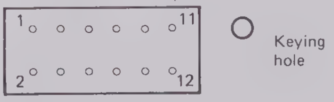
XMT ATTEN
HP Filter
4.5 dB
0 TLP Transmit
−3 TLP Receive
T1
R1
TEST
Hybrid
RCV ATTEN
3.0 dB
XMT TANDEM ATTEN
T
R
−16 TLP Transmit
0 dB
HP Filter
XMT ATTEN
1.5 dB
TEST
RCV TANDEM ATTEN
T1
R1
+7 TLP Receive
0 dB
RCV ATTEN
1.5 dB

Figure E. Channel Unit Interface with 91442 VF Test Set or 91443 Test Patch Panel (Note 1)



91442 or 91443 (Note 2)
CHANNEL UNIT
Receptacle Connector
CARR Jacks
DROP Jacks
T
R
T1
R1
E
M
1 2 3 4 9 10 11 12 7 8 5 6
796A Patch Cord
1 → 2
2 → 1
3 → 4
4 → 3
9 → 10
10 → 9
11 → 12
12 → 11
7 → 8
8 → 7
5 → 6
6 → 5
Channel Unit
TEST
Receptacle Connector
Drop
Carrier
T
R
T1
R1
E
M

Front View of TEST or CHANNEL UNIT Receptacle Connector



1
11
2
12
Keying hole

Notes:

1. TEST on the channel unit is patched to CHANNEL UNIT on the 91442 or 91443 with a 796A cord. The normal-through contacts on the receptacle connectors open when the cord is inserted.
2. Contacts of the CHANNEL UNIT receptacle connector are normal-through on the 91442 but not on the 91443.

Figure 4-2. Effect of Channel Unit NORM/BUSY Switch on End-to-End Testing

Channel Units	Strapping Plug Positions	NORM/BUSY Switch in BUSY
91402 2W E&M, 91404 4W E&M	R	Inhibits E relay (model 1); does not affect E relay (model 2)
	R and K	Grounds C1 lead if code A is equipped.
	S	Operates E relay, forcing a local busy.
	O (model 2)	Sends off-hook via M lead to force a remote busy.
	P (model 2)	Does not affect M lead.
91403 DPO	All options	Removes vf transmit mute.
	B, D, and J	Operates B relay, grounding C lead. See Note 1.
	A, C, and F	Operates B relay, closing B1-B2 leads.
91405 DPT	None	Sends reverse battery indication to originating end; disables P relay. See Note 2.

Notes:

1. DPO Channel Unit. If strapping is B, D, and J, a reverse battery indication sent from the DPT channel unit releases the F relay in the DPO channel unit, grounding the C lead. If reverse battery is the normal (idle) condition at the DPT channel unit, this feature is disabled at the DPO channel unit by strapping A, D, I instead of B, D, J.
2. DPT Channel Unit. In end-to-end testing, the NORM/BUSY switch on the DPT channel unit must be in NORM position. Then, a loop closure at the DPO channel unit will operate the P relay on the DPT channel unit.

Figure 4-3. Effect of TMB on Loop Testing

Channel Units	Strapping Plug Positions	Effect of Activated TMB
91402 2W E&M, 91404 4W E&M	O and N	E lead on-hook.
	P and N	E lead on-hook for 2 seconds and then off-hook.
	P and M	E lead off-hook.
91403 DPO	P	B relay operates, grounding C lead. After 2 seconds, C lead is winked open for 50 ms. Normal battery is on tip and ring.
	O	Same as option P except that after 2 seconds, reverse battery is applied to tip and ring.
91405 DPT	No options	P relay is disabled, opening vf path to two-wire drop. See Note 1.

Notes:

1. DPT Channel Unit. In the looped channel performance tests with the 91443 Test Patch Panel, an open plug must be inserted in the E&M CARR jack of the 91443 to force operation of the P relay and remove the vf transmit mute.

Figure 4-4. 91405 DPT Channel Unit, P Relay Control

Figure A. 91405 DPT Channel Unit

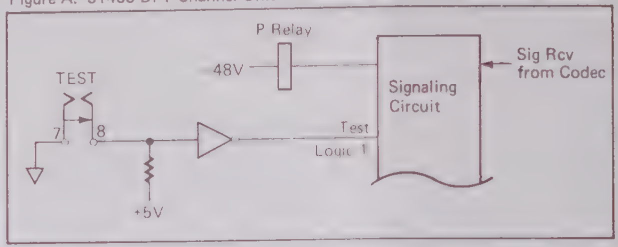


Figure B. Part of Test Setup with 91442 VF Test Set

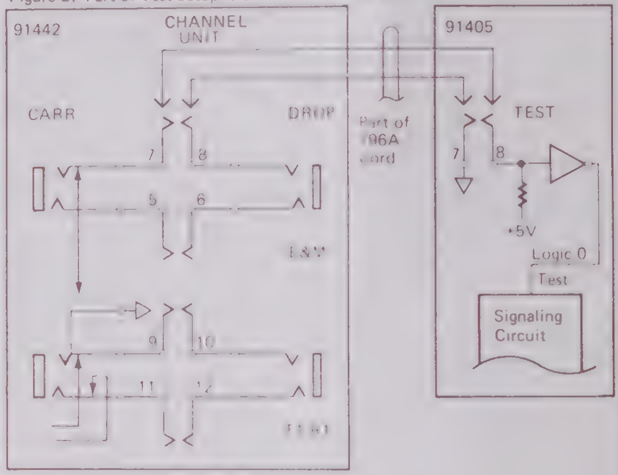
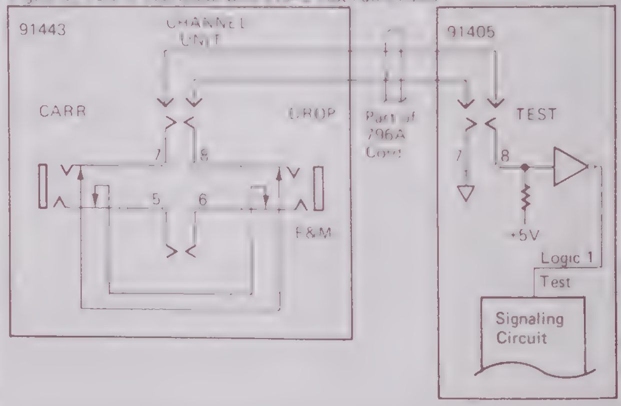


Figure C. Part of Test Setup with 91443 Test Patch Panel



4.17 In end-to-end vf testing, seizure of the channel unit at the originating end operates the P relay, which closes the two-wire vf path and removes the transmit mute. In loop testing, seizure is not possible because signaling is disabled when the channel bank is looped back. However, the P relay is forced to operate by lifting the ground at pin 8 of the TEST connector. This occurs when a 796A Patch Cord is inserted as shown in figures 4-4B and 4-4C. But, note that the circuit through the 91443 panel in figure 4-4C is closed, and an open plug must be inserted in the E&M CARR or DROP jack.

4.18 In end-to-end pulsing tests that utilize the 91442 test set for access to the channel unit, the cord inserted in the T1-R1 CARR jack grounds pin 8 of the channel unit TEST connector (figure 4-4B) to enable P relay operation.

4.19 Pins 7-8 of the TEST connector on an E&M channel unit are assigned to the E lead. As shown in figure 4-4B, the cord inserted in the T1-R1 CARR jack for vf tests grounds the E lead, but the ground is lifted when a cord is inserted in the E&M CARR jack for pulsing tests.

91442 VF Test Set

4.20 The 91442 VF Test Set (figure 4-5) has two independent sections, L on the left and R on the right, and a common center section. In end-to-end tests, the TEST receptacle connector on the channel unit is patched to the CHANNEL UNIT receptacle connector in Section L or Section R, as specified in the procedure. In loop tests, one channel unit is patched to Section L and the other to Section R. Patching is done with 12-conductor 796A Patch Cords.

4.21 The single XMT-RCV toggle switch in the center section has two positions: L-R and R-L. In position L-R, an analog test-tone from the internal oscillator or an external oscillator is routed to the transmit input of a channel unit patched to Section L, and the receive output of a channel unit patched to Section R is routed to the LEVEL, DISTN, and CRSTLK jacks. An external meter is connected to the applicable jack as specified in the procedure. The internal circuit at the DISTN jack includes a 1020-Hz band elimination filter and the circuit at the CRSTLK jack includes a 1020-Hz bandpass filter.

4.22 By setting the XMT-RCV switch to position R-L, the direction of transmission described above is reversed. That is, the test-tone goes to the transmit input of the channel unit patched to Section R, and the receive output of the channel unit patched to Section L goes to the external meter.

4.23 Sections L and R each have three mechanically interlocked VF INTFC pushbutton switches: 2W 600Ω, 2W 900Ω, and 4W 600Ω. Levels and impedances are coordinated between the test set and channel unit by depressing the applicable pushbutton.

4.24 With a channel unit patched to the test set through a 796A cord, the vf and signaling circuits of the channel can be accessed toward the drop and toward the carrier through the test set T-R, T1-R1, and E&M jacks. These jacks are used, for example, in performing pulsing tests with a 26600 Signaling Test Set.

4.25 The transmit and receive attenuators on the test set are switch-selectable in 0.1-dB steps between 0 and 6.3 dB. With these attenuators set at the same values as the strappable attenuators on the channel unit under test, the normal receive level indication on an external meter is 0 dBm. This applies to a two-wire channel unit or to a four-wire channel unit with tandem attenuators strapped for 0 dB loss.

4.26 Test procedures using the 91442 VF Test Set are in figures 4-6 (loop), 4-7 (end-to-end), 4-8 (frequency response), and 4-9 (crosstalk).

91232 Test and Alignment Set

4.27 The 91232 Test and Alignment Set is illustrated and described in Section 342-911-103 (9002A channel bank) and Section 342-911-107 (9002B channel bank). The digital section of the 91232 is not applicable to testing the 9004A channel bank.

4.28 The 91232 test set has a measuring circuit used in conjunction with an external meter, such as the TTS-37B Noise Measuring Set; it also supplies a 1025-Hz test tone at 0 dBm or —16 dBm. The measuring circuit is passive, but the test-tone oscillator operates from —48 volts. When required, a connection to office battery is made at the 48V/OUT jack with a 725A Cord. (The jack is a 48-volt output in 9002A/B applications.)

4.29 In operation of the 91232 test set, the interface with the channel unit under test is made through a 91443 Test Patch Panel (figure 4-10). The CHANNEL UNIT receptacle connector on the 91443 is connected to the TEST receptacle connector on the channel unit with a 796A Patch Cord. Vf circuits and E&M signaling leads toward the drop and toward the channel unit appear at miniature tip-ring-sleeve DROP and CARR jacks, respectively. As required, the TRANSMIT and RECEIVE jacks on the 91232 are connected to the T-R or T1-R1 CARR jacks on the 91443.

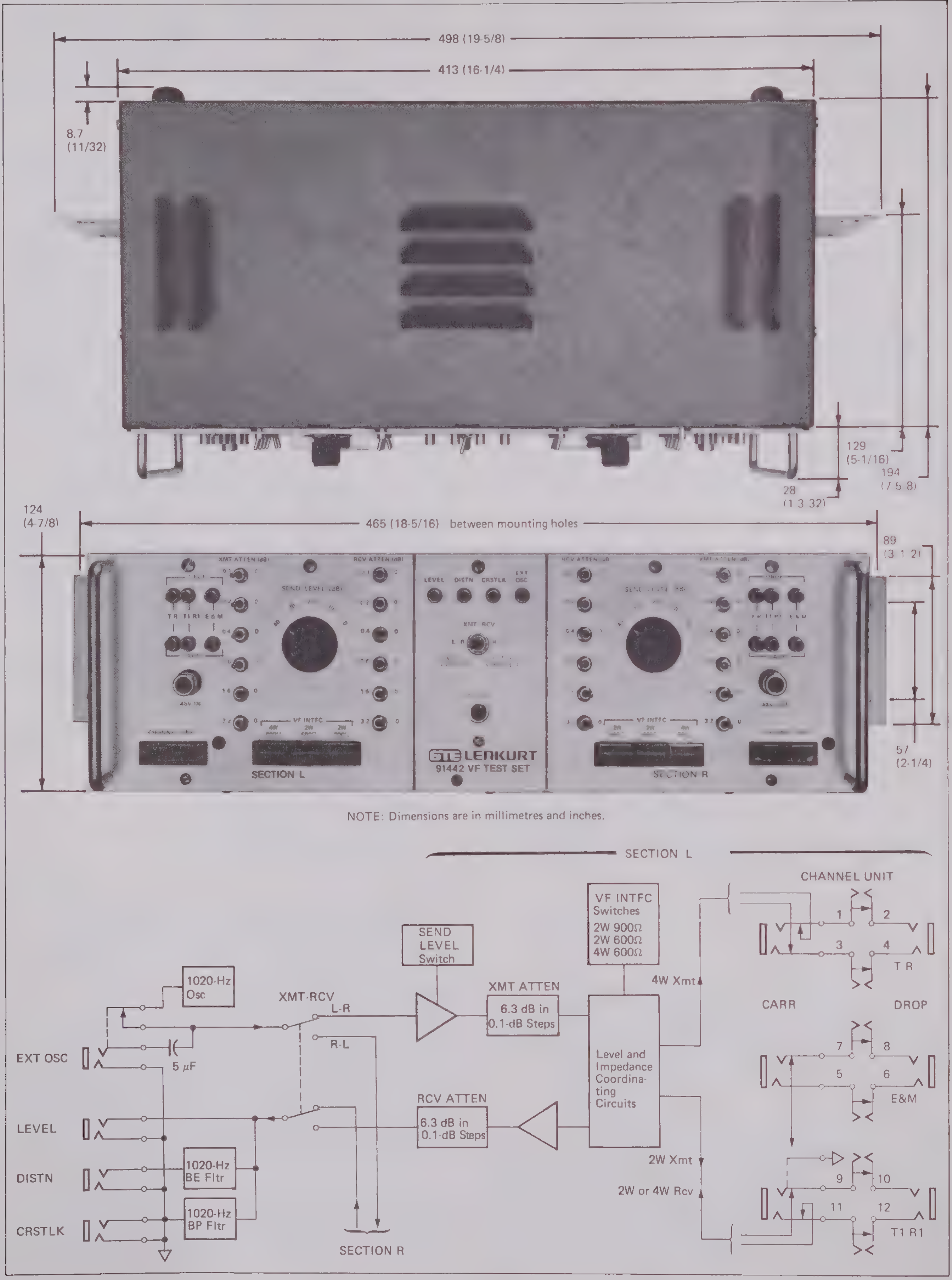
4.30 In figure 4-1, the transmit/receive attenuators on the channel unit are shown strapped for 4.5/3.0 dB two-wire or 1.5/1.5 dB four-wire. The resulting levels at the TEST connector are 0/—3 dBm two-wire or —16/+7 dBm four-wire. If the attenuators are strapped otherwise, the receive level measured using the 91232 test set will be affected accordingly.

4.31 As an example, assume that to compensate for 0.4-dB office wiring loss, the 6.3-dB transmit and receive attenuators in a near-end four-wire channel unit are strapped for 1.1 dB instead of 1.5 dB. If a —16 dBm test tone from the 91232 test set is applied to the channel unit at either end, the receive level measured at the other end should be +7.4 dBm. Moreover, if a 0.6-dB office wiring loss compensation is made in the far-end channel unit, the measured receive level should be +8.0 dBm.

4.32 In loop testing, the vf receive level is checked using a 0-dBm0 digital test tone. In this case, the receive level is not affected by the transmit channel unit attenuator setting.

4.33 Test procedures using the 91232 test set are in figures 4-11 (loop), 4-12 (end-to-end), 4-13 (frequency response), and 4-14 (crosstalk).

Figure 4-5. 91442 VF Test Set



NOTE: Dimensions are in millimetres and inches.

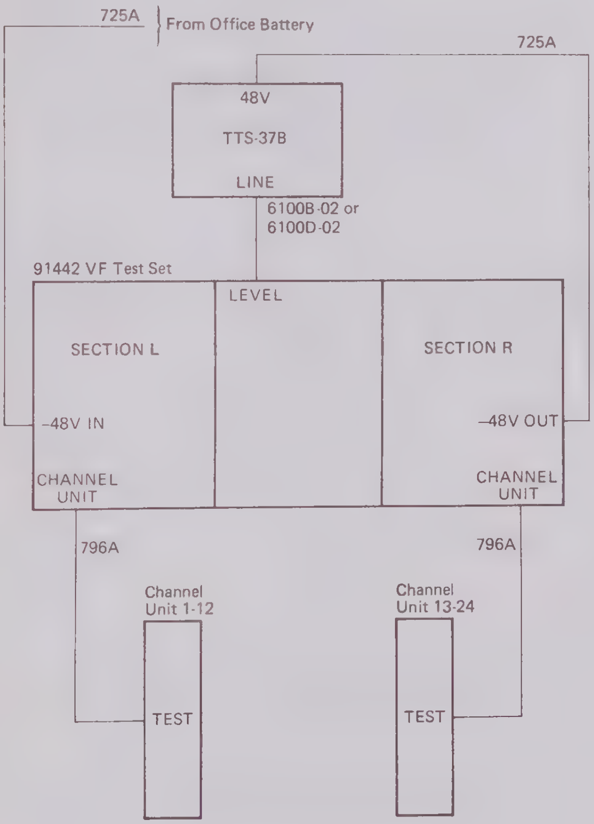
498 (19-5/8)
413 (16-1/4)
8.7
(11/32)
129
(5-1/16)
194
(7 5 8)
28
(1 3 32)
124
(4-7/8)
465 (18-5/16) between mounting holes
89
(3 1 2)
57
(2-1/4)
XMT ATTEN (dB)
RCV ATTEN (dB)
SEND LEVEL (dB)
TR
T1 R1
E&M
48V IN
VF INTFC
4W
2W
2W
SECTION L
LEVEL
DISTN
CRSTLK
EXT OSC
XMT
RCV
GTE LENKURT
91442 VF TEST SET
SECTION R
SECTION L
CHANNEL UNIT
VF INTFC
Switches
2W 900Ω
2W 600Ω
4W 600Ω
SEND
LEVEL
Switch
1020-Hz
Osc
XMT-RCV
L-R
R-L
XMT ATTEN
6.3 dB in
0.1-dB Steps
4W Xmt
Level and
Impedance
Coordinating
Circuits
EXT OSC
5 μF
LEVEL
DISTN
CRSTLK
1020-Hz
BE Fltr
1020-Hz
BP Fltr
RCV ATTEN
6.3 dB in
0.1-dB Steps
2W Xmt
2W or 4W Rcv
SECTION R
1
2
3
4
T R
CARR
DROP
7
8
5
6
E&M
9
10
11
12
T1 R1

Figure 4-6. Looped Channel Performance Test with 91442 VF Test Set (Sheet 1 of 2)

Description of Test. The digital transmit signal of the channel bank is looped to the receive branch, linking the channels in pairs with a 12-channel offset: 1 and 13, 2 and 14, 3 and 15, etc. In mode 1, the loop affects both digroups; in modes 2 and 3, the digroups can be looped independently.

Each pair of channel units is tested in both directions for vf level, idle noise, and distortion. Vf level is measured at the output of the receive channel unit, first with a digital test tone and then with an analog test tone.

CAUTION: To prevent blowing a —48V fuse by accidentally grounding the tip of the 725A Cord, connect the 725A to the load before the supply; disconnect from the supply before the load.



Step	Procedure
1	Digital Loopback If the SYS ALM lamp on the alarm control unit is dark, create a system alarm, and then complete the next two steps within 10 seconds. NOTE: In mode 1 or 3, the recommended way to initiate a system alarm is to open or short-circuit the digital receive line signal for a few seconds. If this is not convenient, or if the channel bank is mode 2, momentarily unplug the alarm control unit, A or B as applicable.
1b	Depress and release ACO pushbutton. ACO indicator should light.
1c	Depress LOOP pushbutton. Green LOOP indicator should light.
2	Test Set Calibration Check
2a	Set up test circuit shown in diagram except omit connections to channel units.
2b	Set controls on TTS-37B as follows: INPUT to 600Ω TERM HOLD to OFF FILTER to 3 KC
2c	In Sections L and R of the 91442, set controls as follows: XMT ATTEN to 4.5 dB RCV ATTEN to 0 dB VF INTFC to 2W 600Ω SEND LEVEL to 0 dB
2d	With a 6100C-02 Cord, connect together the T1-R1 DROP jacks in Sections L and R.
2e	In turn, set XMT-RCV switch on 91442 to position L-R and R-L. In each switch position, meter should read 0 ±0.1 dBm. (Tolerance does not include an allowance for meter accuracy; see paragraph 4.05).
2f	Disconnect cord between T1-R1 DROP jacks.
3	Test Setup
3a	Select the channel unit pair for testing; for example, 1A and 13A (digroup A).
3b	In Sections L and R of the 91442, set controls as follows: VF INTFC to channel unit impedance, 2W or 4W. XMT ATTEN and RCV ATTEN to dB values strapped on channel unit (para 4.25).
3c	Connect 91442 to channel units as shown in diagram.
4	VF Level
4a	Set FILTER switch on TTS-37B to 3 KC.
4b	Set slide switch on receive unit to ON (up) position. Green TONE indicator(s) should light.
4c	In turn, set XMT-RCV switch to L-R and R-L. In each position, meter should read 0 ±0.2 dBm (digital test tone). (Tolerance does not include an allowance for meter accuracy; see paragraph 4.05.)
4d	Restore slide switch on receive unit to OFF (down) position. Green TONE indicator(s) should go dark.
4e	In turn, set XMT-RCV switch to L-R and R-L. In each position, meter should read 0 ±0.3 dBm (analog test tone). (Tolerance does not include an allowance for meter accuracy; see paragraph 4.05.)
5	Idle Noise see addl - 211
5a	Set FILTER switch on TTS-37B to C MSG.
5b	Insert an open plug, ~~terminating plug, or cord~~ in EXT OSC jack on 91442. (This disconnects the internal test tone source.)
5c	In turn, set XMT-RCV switch to L-R and R-L. In each position, meter reading should not exceed 23 dBrnc.
5d	Remove plug ~~or cord~~ from EXT OSC jack.
6	Distortion see add
6a	Set FILTER switch on TTS-37B to C MSG.

Figure 4-6. Looped Channel Performance Test with 91442 VF Test Set (Sheet 2 of 2)

Step	Procedure
6b	Connect TTS-37B to DISTN jack (instead of LEVEL jack) on 91442.
6c	Set XMT-RCV switch to L-R.
6d	In turn, set SEND LEVEL switch in Section L to each of its five positions. Meter readings should not exceed the following: SEND LEVEL — Meter 0 dB — 57 dBrnc —10 dB — 47 dBrnc —20 dB — 37 dBrnc —30 dB — 27 dBrnc —40 dB — 23 dBrnc
6e	Restore SEND LEVEL switch to 0 dB.
6f	Set XMT-RCV switch to R-L.
6g	Same as step 6d except in Section R.
6h	Restore SEND LEVEL switch to 0 dB.
6i	If other channels are to be tested, reconnect TTS-37B to LEVEL jack on 91442.
7	Completion of Test
7a	Disconnect 796A cord from channel unit.
7b	Check that NORM/BUSY switch on channel units is set to NORM.
8	Channel Bank Mode 1
8a	To test the next channel unit pair, return to step 3.
8b	Test channel unit pairs in succession through both digroups: 1A-13A through 12A-24A and 1B-13B through 12B-24B.
8c	When all channels have been tested in both directions, release the LOOP pushbutton.
9	Channel Bank Mode 2 or 3
9a	To test the next channel unit pair, return to step 3.
9b	Test channel unit pairs in succession through one digroup: 1A-13A through 12A-24A or 1B-13B through 12B-24B.
9c	When all channels of the digroup have been tested in both directions, release the LOOP pushbutton.
9d	To test the other digroup, do step 1 and then return to step 3.

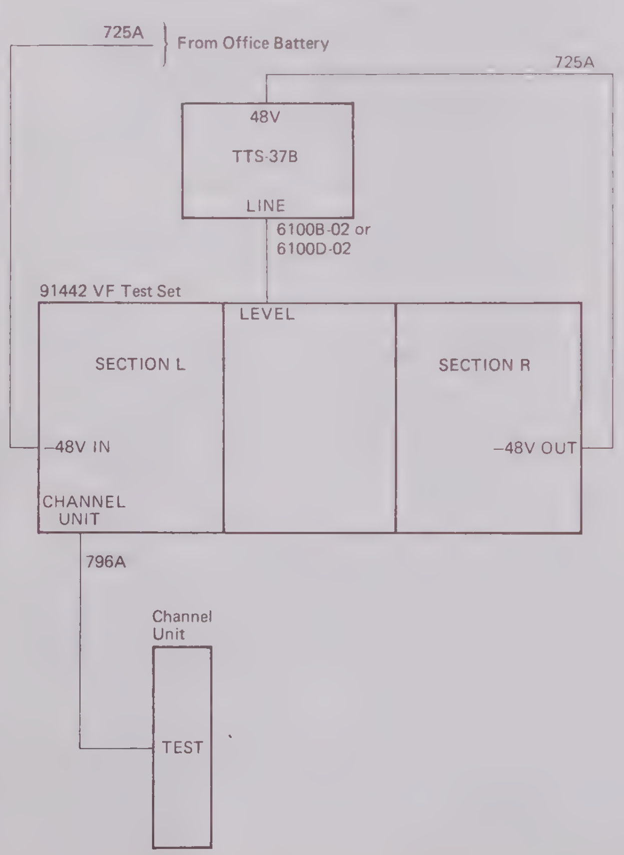
Figure 4-7. End-to-End Channel Performance Test with 91442 VF Test Set (Sheet 1 of 2)

Description of Test. The channel is tested in both directions of transmission for vf level (analog test tone), idle noise, distortion, and impulse noise.

Channel banks are designated "L" and "R" arbitrarily. As shown in the diagram, the channel units are connected to Section L (left) and Section R (right) of the 91442 VF Test Set at bank L and bank R, respectively.

Test Setup at Bank L

CAUTION: To prevent blowing a —48V fuse by accidentally grounding the tip of the 725A Cord, connect the 725A to the load before the supply; disconnect from the supply before the load.


725A
From Office Battery
725A
48V
TTS-37B
LINE
6100B-02 or
6100D-02
91442 VF Test Set
LEVEL
SECTION L
SECTION R
—48V IN
—48V OUT
CHANNEL
UNIT
796A
Channel
Unit
TEST

Test Setup at Bank R

CAUTION: To prevent blowing a —48V fuse by accidentally grounding the tip of the 725A Cord, connect the 725A to the load before the supply; disconnect from the supply before the load.

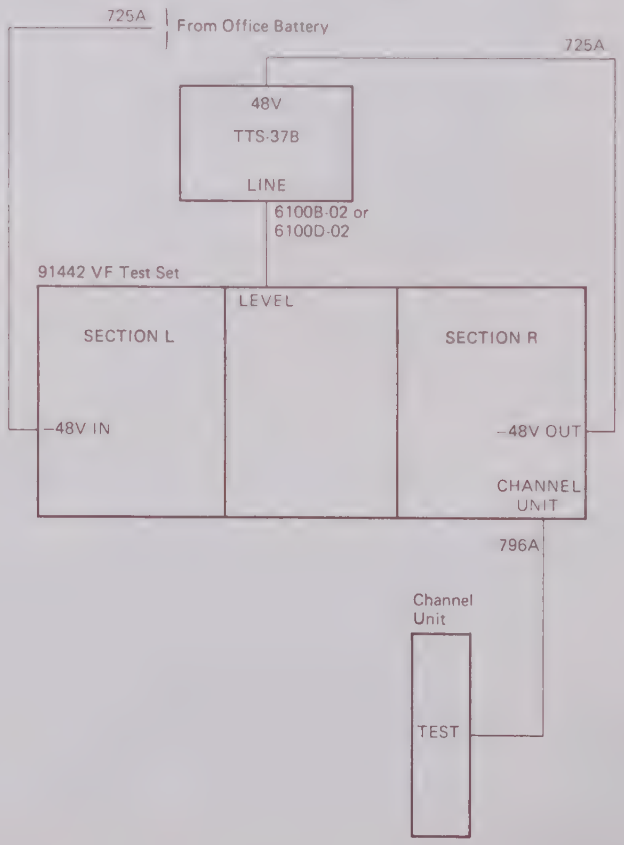

725A
From Office Battery
725A
48V
TTS-37B
LINE
6100B-02 or
6100D-02
91442 VF Test Set
LEVEL
SECTION L
SECTION R
—48V IN
—48V OUT
CHANNEL
UNIT
796A
Channel
Unit
TEST

Figure 4-7. End-to-End Channel Performance Test With 91442 VF Test Set (Sheet 2 of 2)

Step	Procedure
	NOTE: Unless otherwise specified, perform all steps at each channel bank.
1	Test Set Calibration Check
1a	Set up test circuit shown in diagram except omit connection to channel unit.
1b	Set controls on TTS-37B as follows: INPUT to 600Ω TERM HOLD to OFF FILTER to 3 KC
1c	In Sections L and R of the 91442, set controls as follows: XMT ATTEN to 4.5 dB RCV ATTEN to 0 dB VF INTFC to 2W 600Ω SEND LEVEL to 0 dB
1d	With a 6100C-02 Cord, connect together the T1-R1 DROP jacks in Sections L and R.
1e	In turn, set XMT-RCV switch on 91442 to position L-R and R-L. In each switch position, meter should read 0 ±0.1 dBm. (Tolerance does not include an allowance for meter accuracy; see paragraph 4.05.)
1f	Disconnect cord between T1-R1 DROP jacks.
2	Channel Unit Setup
2a	At bank L in Section L of the 91442, set controls as follows: VF INTFC to channel unit impedance, 2W or 4W. XMT ATTEN and RCV ATTEN to dB values strapped on channel unit (para 4.25).
2b	At bank R, same as step 2a except in Section R of the 91442.
2c	Condition the channel for vf testing as described in paragraph 4.13.
2d	Connect 91442 to channel unit as shown in diagram.
3	VF Level
3a	Set FILTER switch on TTS-37B to 3 KC.
3b	At each bank, set XMT-RCV switch to R-L. At bank L, meter should read 0 ±0.3 dBm. (Tolerance does not include an allowance for meter accuracy; see paragraph 4.05.)
3c	At each bank, set XMT-RCV switch to L-R. At bank R, meter should read 0 ±0.3 dBm. (Tolerance does not include an allowance for meter accuracy; see paragraph 4.05.)
4	Idle Noise
4a	At bank L, set XMT-RCV switch to R-L.
4b	At bank R, set XMT-RCV switch to L-R.
4c	At each bank, set FILTER switch on TTS-37B to C MSG. Meter reading should not exceed 23 dBrnc.
5	Distortion
5a	Connect TTS-37B to DISTN jack (instead of LEVEL jack) on 91442.
5b	Set FILTER switch on TTS-37B to C MSG.
5c	Set XMT-RCV switch to L-R.
5d	At bank L, in turn, set SEND LEVEL switch on 91442 to each of its five positions. Meter readings at bank R should not exceed the following: SEND LEVEL — Meter 0 dB — 57 dBrnc —10 dB — 47 dBrnc —20 dB — 37 dBrnc —30 dB — 27 dBrnc —40 dB — 23 dBrnc
5e	Set XMT-RCV switch to R-L.
5f	At bank R, in turn, set SEND LEVEL switch to each of its five positions. Meter readings at bank L should not exceed the values listed in step 5d.
5g	Restore SEND LEVEL switch to 0 dB.
5h	Reconnect TTS-37B to LEVEL jack on 91442.
6	Impulse Noise
6a	Replace TTS-37B in test setup with TTS-58A Impulse Noise Counter.
6b	At bank L, set XMT-RCV switch to R-L.
6c	At bank R, set XMT-RCV switch to L-R.
6d	Set controls on TTS-58A as follows: INPUT to 600 BRDG/TERM to TERM HOLD to OFF WTG to VOICE POWER to ON
6e	Set HI LEVEL and MID LEVEL 2-dB step attenuator switches to 20.
6f	Set REF LEVEL switches for LO LEVEL to 58.
6g	Set all counters to 0000.
6h	Turn TIME control to 5 minutes.
6i	After 5 minutes, LO LEVEL counter should not read more than 0005.
6j	If other testing is to be done, replace TTS-58A in test setup with TTS-37B.
7	Conclusion of Test
7a	Disconnect 796A cord from channel unit.
7b	Restore channel to service.
7c	If other channels are to be tested, return to step 2. Otherwise disconnect the test setup.

Figure 4-8. Channel Frequency Response Test with 91442 VF Test Set (Sheet 1 of 2)

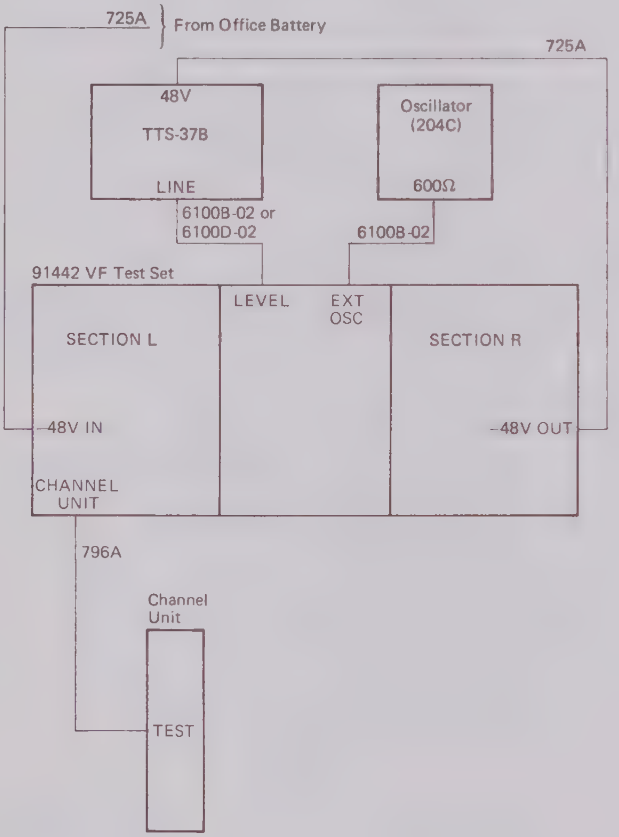
Description of Test. Channel frequency response is measured at 200 Hz and 3400 Hz relative to 1020 Hz, end-to-end in both directions.

Two-wire channel units should be strapped so that NBO capacitors and balance networks are disconnected from the hybrid. Otherwise, the response at 3400 Hz will be degraded.

Channel banks are designated "L" and "R" arbitrarily. As shown in the diagram, the channel units are connected to Section L (left) and R (right) of the 91442 VF Test Set at bank L and bank R, respectively.

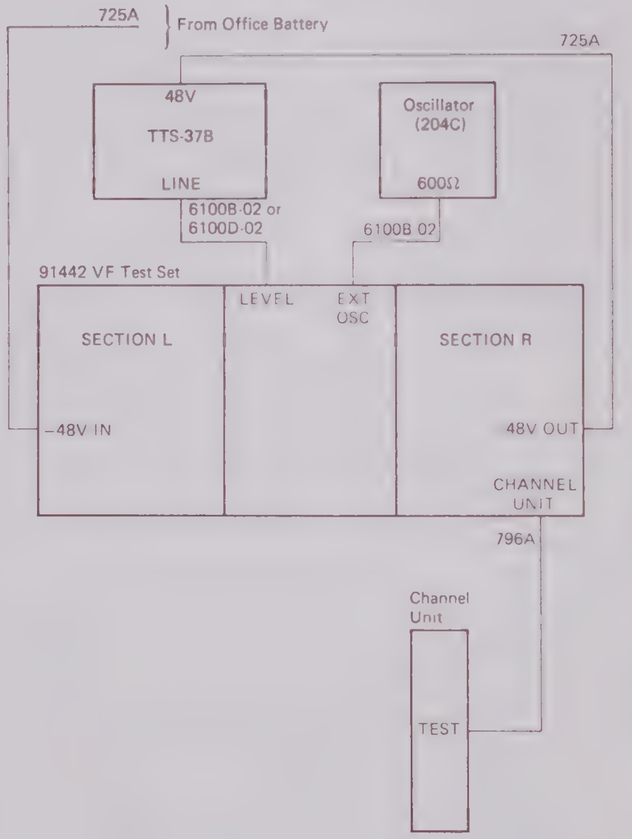
Test Setup at Bank L

CAUTION: To prevent blowing a –48V fuse by accidentally grounding the tip of the 725A Cord, connect the 725A to the load before the supply; disconnect from the supply before the load.


725A
From Office Battery
725A
48V
TTS-37B
LINE
Oscillator (204C)
600Ω
6100B-02 or 6100D-02
6100B-02
91442 VF Test Set
LEVEL
EXT OSC
SECTION L
SECTION R
–48V IN
–48V OUT
CHANNEL UNIT
796A
Channel Unit
TEST

Test Setup at Bank R

CAUTION: To prevent blowing a –48V fuse by accidentally grounding the tip of the 725A Cord, connect the 725A to the load before the supply; disconnect from the supply before the load.


725A
From Office Battery
725A
48V
TTS-37B
LINE
Oscillator (204C)
600Ω
6100B-02 or 6100D-02
6100B 02
91442 VF Test Set
LEVEL
EXT OSC
SECTION L
SECTION R
–48V IN
48V OUT
CHANNEL UNIT
796A
Channel Unit
TEST

Step	Procedure
1	Test Set Calibration Check at Each Bank
1a	Set up test circuit shown in diagram except omit connection to channel unit and oscillator.
1b	Set controls on TTS-37B as follows: INPUT to 600Ω TERM HOLD to OFF FILTER to 3 KC
1c	In Sections L and R of the 91442, set controls as follows: XMT ATTEN to 4.5 dB RCV ATTEN to 0 dB VF INTFC to 2W 600Ω SEND LEVEL to 0 dB
1d	With a 6100C-02 Cord, connect together the T1-R1 DROP jacks in Sections L and R.
1e	In turn, set XMT-RCV switch on 91442 to position L-R and R-L. In each switch position, meter should read 0 ±0.1 dBm. (Tolerance does not include an allowance for meter accuracy; see paragraph 4.05.)

Figure 4-8. Channel Frequency Response Test with 91442 VF Test Set (Sheet 2 of 2)

Step	Procedure
1f	Disconnect cord between T1-R1 DROP jacks.
2	Test Tone Calibration at Each Bank
2a	Connect oscillator to 91442 as shown in diagram.
2b	Connect TTS-37B to T1-R1 DROP jack in Section L (instead of LEVEL jack) on 91442.
2c	Set FILTER switch on TTS-37B to 15 KC.
2d	Set XMT-RCV switch to L-R.
2e	Set oscillator frequency at 1020 Hz.
2f	Adjust oscillator output level for a meter reading of 0.0 dBm.
2g	In turn, set oscillator frequency at 200 Hz and 3400 Hz and record meter readings.
2h	Connect TTS-37B to LEVEL jack on 91442.
3	Channel Unit Setup at Each Bank
3a	At bank L in Section L of the 91442, set controls as follows: VF INTFC to channel unit impedance, 2W or 4W. XMT ATTEN and RCV ATTEN to dB values strapped on channel unit (para 4.25).
3b	At bank R, same as step 3a except in Section R of the 91442.
3c	Condition the channel for vf testing as described in paragraph 4.13.
3d	Connect 91442 to channel unit as shown in diagram.
4	Frequency Response, Bank L to Bank R
4a	At each bank, set XMT-RCV switch to L-R.
4b	At bank L, set oscillator frequency at 1020 Hz and adjust output level for a meter reading of 0.0 dBm at bank R.
4c	At bank L, set oscillator frequency at 200 Hz and record meter reading at bank R.
4d	To correct for oscillator frequency response, algebraically subtract the 200 Hz level recorded in step 2g from the reading in step 4c; for example, —1.4 — (—0.3) = —1.1 dB.
4e	Repeat step 4c at 3400 Hz.
4f	Repeat step 4d at 3400 Hz.
4g	Based on the corrected readings of steps 4d and 4f, the frequency response at 200 Hz and 3400 Hz relative to 1020 Hz should be 0 to —3 dB. NOTE: If the channel unit at bank L or R is two-wire, the requirement at 200 Hz is 0 to —5 dB.
5	Frequency Response, Bank R to Bank L
5a	At each bank, set XMT-RCV switch to R-L.
5b	Same as step 4 except adjust oscillator at bank R and read meter at bank L.
6	Conclusion of Test
6a	Disconnect 796A cord from channel unit.
6b	Restore channel to service.
6c	If other channels are to be tested, return to step 3.

Figure 4-9. Channel Crosstalk Test with 91442 VF Test Set (Sheet 1 of 2)

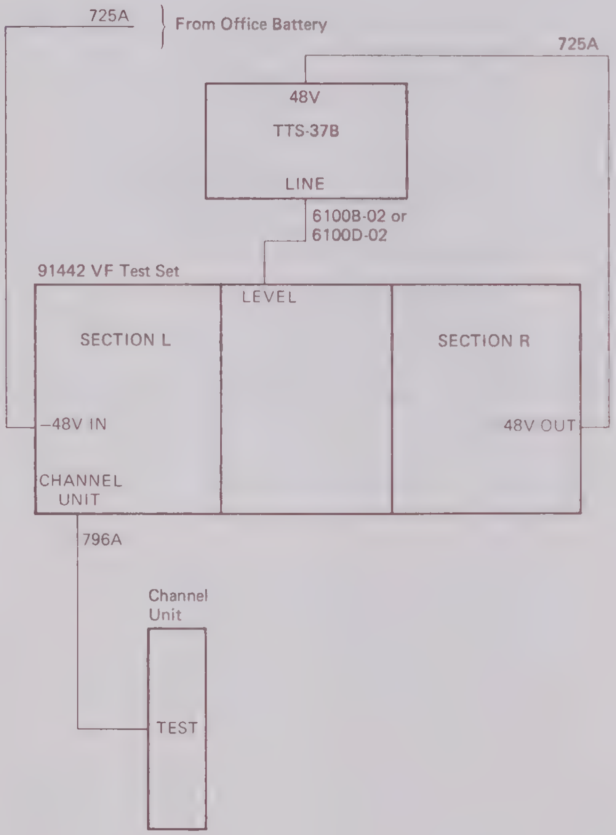
Description of Test. First, a 1020-Hz test tone is transmitted over the channel under test and vf receive level is checked. Then, the test tone is transferred to the two adjacent channels, one at a time, and the crosstalk level in the channel under test is measured.

"Adjacent" means in the channel sampling sequence, 1 through 24; for channel 1, the adjacent channels are 24 and 2.

The direction of transmission in this test is from bank L to bank R. As shown in the diagram, the channel units are connected to Section L (left) and Section R (right) of the 91442 VF Test Set at bank L and bank R, respectively.

Test Setup at Bank L

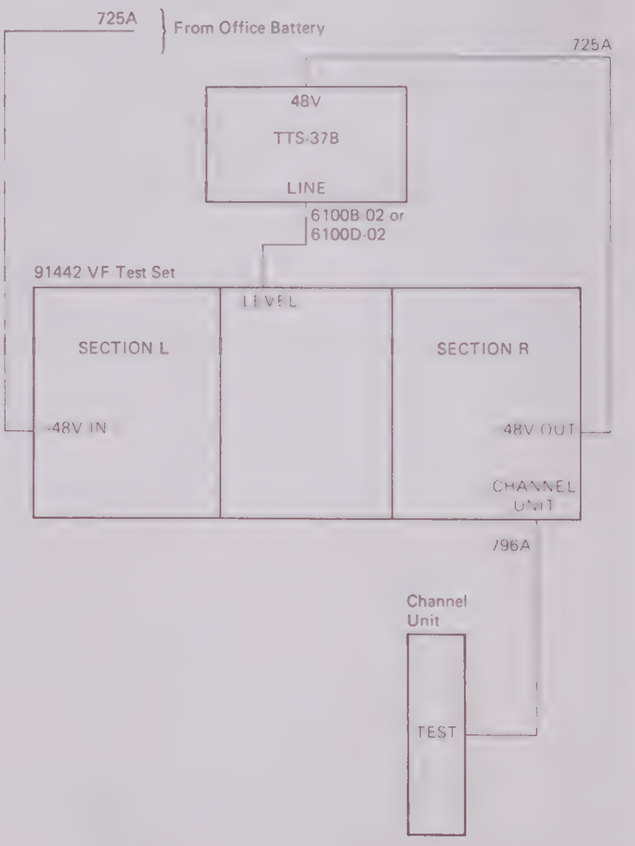
CAUTION: To prevent blowing a −48V fuse by accidentally grounding the tip of the 725A Cord, connect the 725A to the load before the supply; disconnect from the supply before the load.



725A
From Office Battery
725A
48V
TTS-37B
LINE
6100B-02 or
6100D-02
91442 VF Test Set
LEVEL
SECTION L
SECTION R
−48V IN
48V OUT
CHANNEL UNIT
796A
Channel Unit
TEST

Test Setup at Bank R

CAUTION: To prevent blowing a −48V fuse by accidentally grounding the tip of the 725A Cord, connect the 725A to the load before the supply; disconnect from the supply before the load.



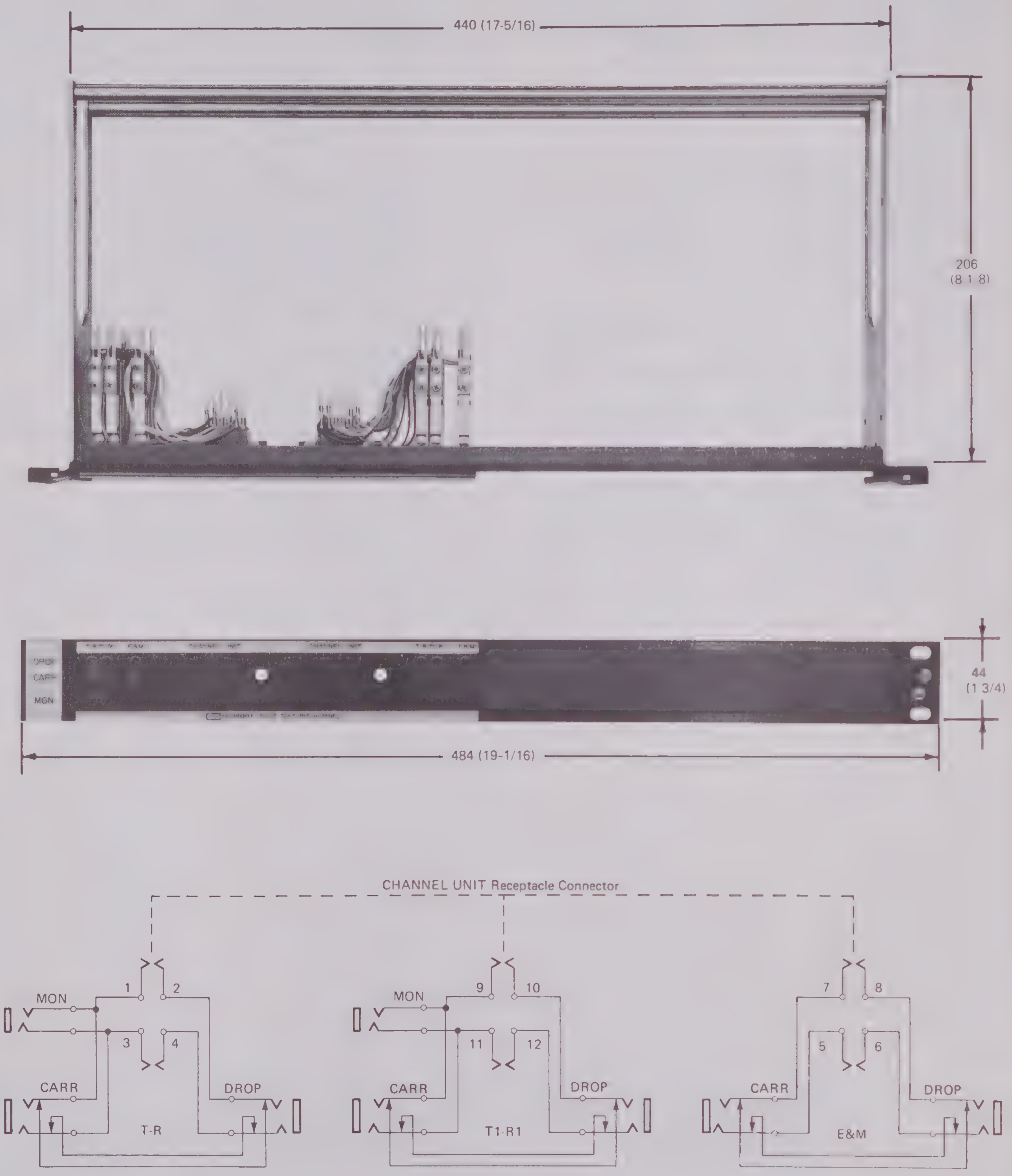
725A
From Office Battery
725A
48V
TTS-37B
LINE
6100B-02 or
6100D-02
91442 VF Test Set
LEVEL
SECTION L
SECTION R
-48V IN
48V OUT
CHANNEL UNIT
796A
Channel Unit
TEST

Step	Procedure
1	Test Set Calibration Check at Each Bank
1a	Set up test circuit shown in diagram except omit connection to channel unit.
1b	Set controls on TTS-37B as follows: INPUT to 600Ω TERM HOLD to OFF FILTER to 3 KC
1c	In Sections L and R of the 91442, set controls as follows: XMT ATTEN to 4.5 dB RCV ATTEN to 0 dB VF INTFC to 2W 600Ω SEND LEVEL to 0 dB
1d	With a 6100C-02 Cord, connect together the T1-R1 DROP jacks in Sections L and R.
1e	In turn, set XMT-RCV switch on 91442 to position L-R and R-L. In each switch position, meter should

Figure 4-9. Channel Crosstalk Test with 91442 VF Test Set (Sheet 2 of 2)

Step	Procedure
	read 0 ±0.1 dBm. (Tolerance does not include an allowance for meter accuracy; see paragraph 4.05.)
1f	Disconnect cord between T1-R1 DROP jacks.
1g	Set XMT-RCV switch on 91442 to L-R.
1h	Transfer test cord from LEVEL jack to CRSTLK jack on 91442.
1i	Set controls on TTS-37B as follows: INPUT to 600Ω BRDG FILTER to C MSG
2	Channel Status. Condition the channel under test and the adjacent channels for vf testing as described in paragraph 4.13.
3	Channel Under Test at Bank L
3a	In Section L of the 91442, set controls as follows: VF INTFC to channel unit impedance, 2W or 4W. XMT ATTEN to dB value strapped on channel unit (para 4.25).
3b	Connect 91442 to channel unit as shown in diagram.
4	Channel Under Test at Bank R
4a	In Section R of the 91442, set controls as follows: VF INTFC to channel unit impedance, 2W or 4W. RCV ATTEN to dB value strapped on channel unit (para 4.25).
4b	Connect 91442 to channel unit as shown in diagram.
4c	Meter should read 0 dB. As required, change the settings of the RCV ATTEN switches in Section R to obtain a 0-dB reading. NOTE: If the meter cannot be operated in bridging mode, use —9 dB as the reference level instead of 0 dB.
5	First Adjacent Channel at Bank L
5a	Same as step 3 except on the channel adjacent to the channel under test.
5b	At bank R, meter reading should not exceed 25 dBrnc (16 dBrnc if the reference level is —9 dB).
6	Second Adjacent Channel at Bank L. Same as step 5.
7	Conclusion of Test.
7a	Disconnect 796A cord from channel units.
7b	Restore channels to service.
7c	If other channels are to be tested, return to step 2. Otherwise, disconnect test setup.

Figure 4-10. 91443 Test Patch Panel


440 (17-5/16)
206 (8-1/8)
DROP
CARR
MON
44 (1 3/4)
484 (19-1/16)
CHANNEL UNIT Receptacle Connector
MON
1
2
3
4
CARR
DROP
T-R
MON
9
10
11
12
CARR
DROP
T1-R1
7
8
5
6
CARR
DROP
E&M

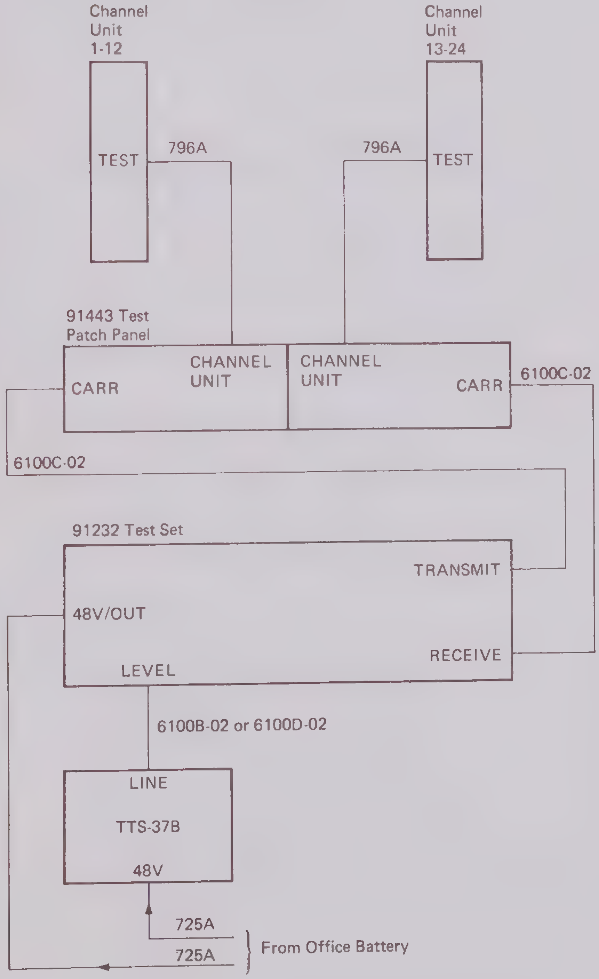
Notes:

1. Dimensions are in millimetres and (inches).
2. Mounting hole centers are 32 mm (1-1/4″) x 465 mm (18-5/16″).
3. The diagram shows one of the two identical circuits.

Figure 4-11. Looped Channel Performance Test with 91232 Test and Alignment Set (Sheet 1 of 2)

Description of Test. The digital transmit signal of the channel bank is looped to the receive branch, linking the channels in pairs with a 12-channel offset: 1 and 13, 2 and 14, 3 and 15, etc. In mode 1, the loop affects both d groups; in modes 2 and 3, the digroups can be looped independently.

Each pair of channel units is tested in both directions for vf level, idle noise, and distortion. Vf level is measured at the output of the receive channel unit, first with a digital test tone and then with an analog test tone.



CAUTION: To prevent blowing a −48V fuse by accidentally grounding the tip of the 725A Cord, connect the 725A to the load before the supply; disconnect from the supply before the load.

Step	Procedure
1	Digital Loopback
1a	If the SYS ALM lamp on the alarm control unit is dark, create a system alarm, and then complete the next two steps within 10 seconds. NOTE: In mode 1 or 3, the recommended way to initiate a system alarm is to open or short-circuit the digital receive line signal for a few seconds. If this is not convenient, or if the channel bank is mode 2, momentarily unplug the alarm control unit, A or B as applicable.
1b	Depress and release ACO pushbutton. ACO indicator should light.
1c	Depress LOOP pushbutton. Green LOOP indicator should light.
2	Test Setup
2a	Set controls on TTS-37B as follows: INPUT to 600Ω BRDG HOLD to OFF FILTER to 3 KC
2b	Connect TTS-37B to 91232 test set as shown in diagram.
2c	Connect TTS-37B and 91232 test set to office battery as shown in diagram.
3	Test Tone Calibration, 91232 Test Set
3a	Set TRANSMIT ATTENUATOR switch to 0 dB.
3b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress 2W 600Ω button (▲).
3c	While depressing 600Ω CALIBRATION pushbutton, adjust adjacent OSC LEVEL control for meter reading of 0.0 dBm.
3d	Release pushbutton.
4	Channel Unit Pair
4a	Select the channel unit pair for testing; for example, 1A and 13A (digroup A). NOTE: For the first direction of testing, designate the lower-numbered channel unit as "transmit."
4b	Connect 91443 patch panel to selected channel units as shown in diagram.
4c	If the channel unit is 91405 DPT, insert an open plug in the E&M CARR jack on the 91443 patch panel. (This enables the channel unit P relay.)
5	Transmit Channel Unit
5a	Connect TRANSMIT jack on 91232 test set to left-hand CARR jack on 91443 patch panel: T-R jack if channel unit is four-wire or T1-R1 jack if channel unit is two-wire.
5b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress the applicable button.
6	Receive Channel Unit
6a	Connect RECEIVE jack on 91232 test set to right-hand T1-R1 CARR jack on 91443 patch panel.
6b	In the RECEIVE set of CHANNEL TYPE SELECT pushbuttons, depress the applicable button.
7	Receive Level
7a	Set FILTER switch on TTS-37B to 3 KC.
7b	Set slide switch on receive unit to ON (up) position. Green TONE indicators should light.
7c	Meter reading (digital test tone) should be +7 dBm (four-wire) or −3 dBm (two-wire), or as described in paragraph 4.30 according to attenuator strapping on receive channel unit. The tolerance using this test setup is ±0.4 dB. (Tolerance does not include an allowance for meter accuracy; see paragraph 4.05.)

Figure 4-11. Looped Channel Performance Test with 91232 Test and Alignment Set (Sheet 2 of 2)

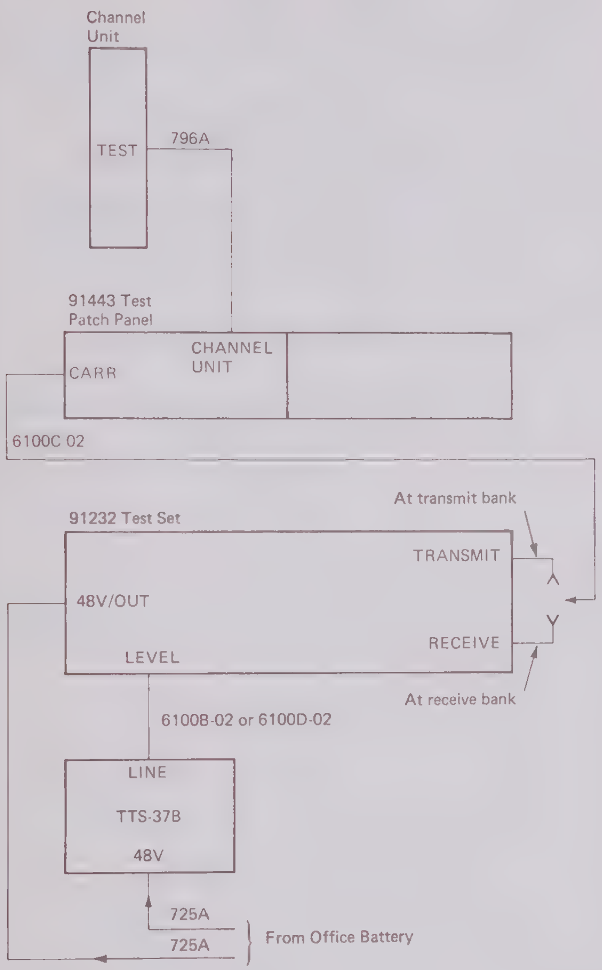
Step	Procedure
7d	Record level as a reference for idle noise test.
7e	Restore slide switch on receive unit to OFF (down) position. Green TONE indicator(s) should go dark.
7f	Meter reading (analog test tone) should be +7 dBm (four-wire) or —3 dBm (two-wire), or as described in paragraph 4.30 according to attenuator strapping on both transmit and receive channel units. The tolerance using this test setup is ±0.6 dB. (Tolerance does not include an allowance for meter accuracy; see paragraph 4.05.)
8	Idle Noise
8a	Set FILTER switch on TTS-37B to C MSG.
8b	Insert 600-ohm terminating plug (6000A-01) in EXTERNAL OSCILLATOR jack on 91232 test set. (This terminates the channel unit input and disconnects the test tone source.)
8c	Meter reading (dBrnc) should not exceed 23 dB higher than level (dBm) recorded in step 7d. For example, 20 dBrnc if the level is —3 dBm.
8d	Remove terminating plug from EXTERNAL OSCILLATOR jack.
9	Distortion
9a	Set FILTER switch on TTS-37B to C MSG.
9b	Connect TTS-37B to DISTN jack (instead of LEVEL jack) on 91232 test set.
9c	Set TRANSMIT ATTENUATOR switch on 91232 test set to 0 dB.
9d	While depressing DISTORTION REFERENCE pushbutton, adjust adjacent control for applicable meter reading as follows: Four-wire channel unit: 90 dBrnc (or 80 if 90 cannot be measured). Two-wire channel unit: 80 dBrnc
9e	Release pushbutton.
9f	With TRANSMIT ATTENUATOR switch at 0 dB, meter reading should not exceed: 57 dBrnc if the reference is 90 47 dBrnc if the reference is 80
9g	Set TRANSMIT ATTENUATOR switch to position A (—20 dB). Meter reading should not exceed: 37 dBrnc if the reference is 90 27 dBrnc if the reference is 80
9h	Set TRANSMIT ATTENUATOR switch to position B (—34 dB). Meter reading should not exceed: 29 dBrnc if the reference is 90 19 dBrnc if the reference is 80
9i	Reconnect TTS-37B to LEVEL jack on 91232 test set.
10	Test Same Pair in Opposite Direction
10a	Same as step 5 except connect to right-hand CARR jack in step 5a.
10b	Same as step 6 except connect to left-hand CARR jack in step 6a.
10c	Repeat steps 7, 8, and 9.
11	Completion of Test
11a	Disconnect 796A cord from channel unit.
11b	Check that NORM/BUSY switch on channel unit is set to NORM.
12	Channel Bank Mode 1
12a	To test the next channel unit pair, return to step 4.
12b	Test channel unit pairs in succession through both digroups: 1A-13A through 12A-24A and 1B-13B through 12B-24B.
12c	When all channels have been tested in both directions, release the LOOP pushbutton.
13	Channel Bank Mode 2 or 3
13a	To test the next channel unit pair, return to step 4.
13b	Test channel unit pairs in succession through one digroup: 1A-13A through 12A-24A or 1B-13B through 12B-24B.
13c	When all channels of the digroup have been tested in both directions, release the LOOP pushbutton.
13d	To test the other digroup, do step 1 and then return to step 4.

Figure 4-12. End-to-End Channel Performance Test with 91232 Test and Alignment Set (Sheet 1 of 2)

Description of Test. The channel is tested in both directions for vf level, idle noise, distortion, and impulse noise.

Channel banks are designated "transmit" and "receive" according to the direction of transmission in the test.

Test Setup at Each Bank



CAUTION: To prevent blowing a —48V fuse by accidentally grounding the tip of the 725A Cord, connect the 725A to the load before the supply; disconnect from the supply before the load.

Step	Procedure
1	Test Setup at Each Bank
1a	Set controls on TTS-37B as follows: INPUT to 600Ω BRDG HOLD to OFF FILTER to 3 KC
1b	Connect TTS-37B to 91232 test set as shown in diagram.
1c	Connect TTS-37B and 91232 test set to office battery as shown in diagram.
2	Test Tone Calibration, 91232 Test Set at Each Bank
2a	Set TRANSMIT ATTENUATOR switch to 0 dB.
2b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress 2W 600Ω button (▲).
2c	While depressing 600Ω CALIBRATION pushbutton, adjust adjacent OSC LEVEL control for meter reading of 0.0 dBm.
2d	Release pushbutton.
3	Channel Unit at Each Bank
3a	Condition the channel for vf testing as described in paragraph 4.13.
3b	Connect channel unit to 91443 patch panel as shown in diagram.
4	Test Setup at Transmit Bank
4a	Connect TRANSMIT jack on 91232 test set to CARR jack on 91443 patch panel: T-R jack if channel unit is four-wire or T1-R1 jack if channel unit is two-wire.
4b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress the applicable button.
5	Test Setup at Receive Bank
5a	Connect RECEIVE jack on 91232 test set to T1-R1 CARR jack on 91443 patch panel.
5b	In the RECEIVE set of CHANNEL TYPE SELECT pushbuttons, depress applicable button.
6	Receive Level
6a	Meter reading at the receive bank should be +7 dBm (four-wire) or —3 dBm (two-wire) or as described in paragraph 4.30 according to channel unit attenuator strapping. The tolerance using this test setup is ±0.6 dB. (Tolerance does not include an allowance for meter accuracy; see paragraph 4.05.)
6b	Record the level as a reference for noise measurements.
7	Idle Noise
7a	At the transmit bank, insert 600-ohm terminating plug (6000A-01) in EXTERNAL OSCILLATOR jack on 91232 test set. (This terminates the channel unit input and disconnects the test tone source.)
7b	At the receive bank, set FILTER switch on TTS-37B to C MSG.
7c	Meter reading (dBrnc) at the receive bank should not exceed 23 dB higher than level (dBm) recorded in step 6b. For example, 20 dBrnc if the level is —3 dBm.
7d	At the transmit bank, remove terminating plug from EXTERNAL OSCILLATOR jack.
8	Distortion
8a	At the transmit bank, set TRANSMIT ATTENUATOR switch on 91232 test set to 0 dB.
8b	At the receive bank, connect TTS-37B to DISTN jack (instead of LEVEL jack) on 91232 test set.
8c	Set FILTER switch on TTS-37B to C MSG.
8d	At the receive bank, while depressing DISTORTION REFERENCE pushbutton, adjust adjacent control for applicable meter reading as follows: Four-wire channel unit: 90 dBrnc (or 80 if 90 cannot be measured) Two-wire channel unit: 80 dBrnc
8e	Release pushbutton.

Figure 4-12. End-to-End Channel Performance Test with 91232 Test and Alignment Set (Sheet 2 of 2)

Step	Procedure
	NOTE: In the next three steps, the TRANSMIT ATTENUATOR switch is on the 91232 test set at the transmit bank; meter readings are at the receive bank.
8f	With TRANSMIT ATTENUATOR switch set at 0 dB, meter reading should not exceed: 57 dBrnc if the reference is 90 47 dBrnc if the reference is 80
8g	Set TRANSMIT ATTENUATOR switch to position A (—20 dB). Meter reading should not exceed: 37 dBrnc if the reference is 90 27 dBrnc if the reference is 80
8h	Set TRANSMIT ATTENUATOR switch to position B (—34 dB). Meter reading should not exceed: 29 dBrnc if the reference is 90 19 dBrnc if the reference is 80
8i	At the receive bank, connect TTS-37B to LEVEL jack on 91232 test set.
9	Impulse Noise
9a	At the transmit bank, insert 600-ohm terminating plug (6000A-01) in EXTERNAL OSCILLATOR jack on 91232 test set.
9b	At the receive bank, replace TTS-37B in test setup with TTS-58A Impulse Noise Counter.
9c	Set controls on TTS-58A as follows: INPUT to 600 BRDG/TERM to BRDG HOLD to OFF WTG to VOICE POWER to ON
9d	Set HI LEVEL and MID LEVEL 2-dB step attenuator switches to 20.
9e	Set REF LEVEL switches for LO LEVEL to 58 + level recorded in step 6b; for example 55 if the level is —3 (or 56 if 55 is not available).
9f	Set all counters to 0000.
9g	Turn TIME control to 5 minutes.
9h	After 5 minutes, LO LEVEL counter should not read more than 0005.
9i	Replace TTS-58A in test setup with TTS-37B.
9j	At the transmit bank, remove terminating plug from EXTERNAL OSCILLATOR jack.
10	Test Channel in Opposite Direction. Repeat steps 4 through 9 with the channel bank designations exchanged; that is, the transmit bank becomes the receive bank, and vice versa.
11	Conclusion of Test
11a	Disconnect 796A cords from channel units.
11b	Restore channel to service.
11c	If other channels are to be tested, return to step 3. Otherwise disconnect the test setup.

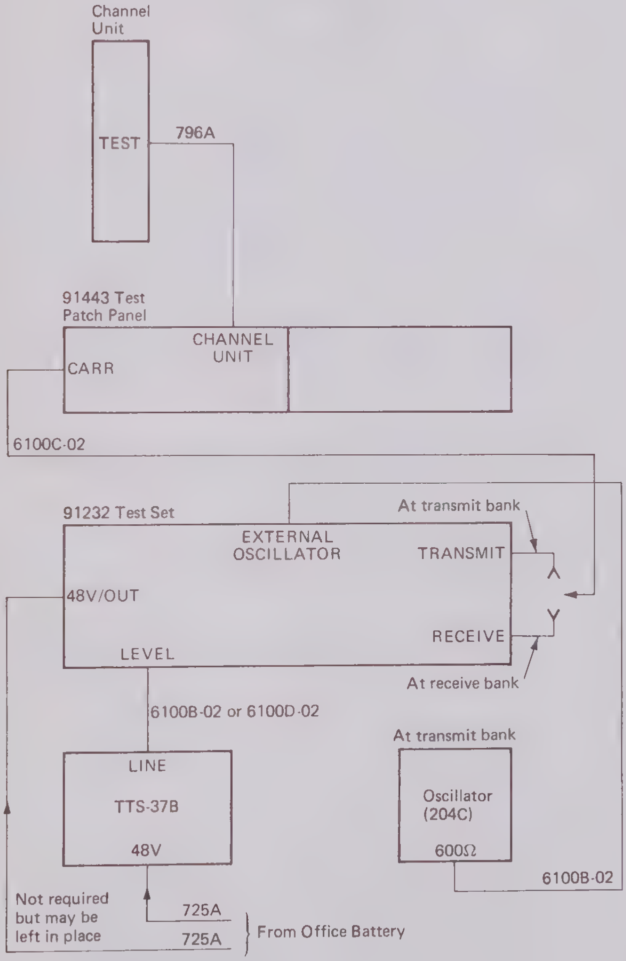
Figure 4-13. Channel Frequency Response Test with 91232 Test and Alignment Set (Sheet 1 of 2)

Description of Test. Channel frequency response is measured at 200 Hz and 3400 Hz relative to 1020 Hz, end-to-end in both directions.

Two-wire channel units should be strapped so that NBO capacitors or balance networks are disconnected from the hybrid. Otherwise, the response at 3400 Hz will be degraded.

Channel banks are designated "transmit" and "receive" according to the direction of transmission in the test.

Test Setup at Each Bank



CAUTION: To prevent blowing a –48V fuse by accidentally grounding the tip of the 725A Cord, connect the 725A to the load before the supply; disconnect from the supply before the load.

Step	Procedure
1	Test Setup at Each Bank
1a	Set controls on TTS-37B as follows: INPUT to 600Ω BRDG HOLD to OFF FILTER to 15 KC
1b	Connect TTS-37B to 91232 test set as shown in diagram.
1c	Connect TTS-37B to office battery as shown in diagram.
2	Test Tone Calibration at Transmit Bank
2a	Connect oscillator to 91232 test set as shown in diagram.
2b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress 2W 600Ω button (▲).
2c	Set oscillator frequency at 1020 Hz.
2d	While depressing 600Ω CALIBRATION pushbutton, adjust oscillator output level for a meter reading of 0.0 dBm.
2e	Set oscillator frequency at 200 Hz. Depress 600Ω CALIBRATION pushbutton and read meter. Record the reading.
2f	Repeat step 2e at 3400 Hz.
3	Channel Unit at Each Bank
3a	Condition the channel for vf testing as described in paragraph 4.13.
3b	Connect channel unit to 91443 patch panel as shown in diagram.
4	Test Setup at Transmit Bank
4a	Connect TRANSMIT jack on 91232 test set to CARR jack on 91443 patch panel: T-R jack if channel unit is four-wire or T1-R1 jack if channel unit is two-wire.
4b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress the applicable button.
5	Test Setup at Receive Bank
5a	Connect RECEIVE jack on 91232 test set to T1-R1 CARR jack on 91443 patch panel.
5b	In the RECEIVE set of CHANNEL TYPE SELECT pushbuttons, depress the applicable button.
6	Reference Level at 1020 Hz
6a	Set oscillator frequency at 1020 Hz.
6b	Adjust oscillator output level for a meter reading at the receive bank of +7.0 dBm (four-wire channel unit) or —3.0 dBm (two-wire channel unit).
7	Frequency Response
7a	Set oscillator frequency at 200 Hz and record meter reading at receive bank.
7b	To correct for oscillator response, algebraically subtract the 200-Hz level recorded in step 2e from the reading in step 7a; for example, +5.5 — (—0.2) = +5.7.
7c	Repeat step 7a at 3400 Hz.
7d	Repeat step 7b at 3400 Hz.
7e	Based on the corrected readings of steps 7b and 7d, the frequency response at 200 Hz and 3400 Hz relative to 1020 Hz should be 0 to —3 dB. NOTE: If the transmit or receive channel unit is two-wire, the requirement at 200 Hz is 0 to —5 dB.
8	Test Channel in Opposite Direction. Repeat steps 2 through 7 with the channel bank designations exchanged; that is, the transmit bank becomes the receive bank, and vice versa.

Figure 4-13. Channel Frequency Response Test with 91232 Test and Alignment Set (Sheet 2 of 2)

Step	Procedure
9	Conclusion of Test
9a	Disconnect 796A cord from channel unit.
9b	Restore channel to service.
9c	If other channels are to be tested, return to step 3. Otherwise, disconnect the test setup.

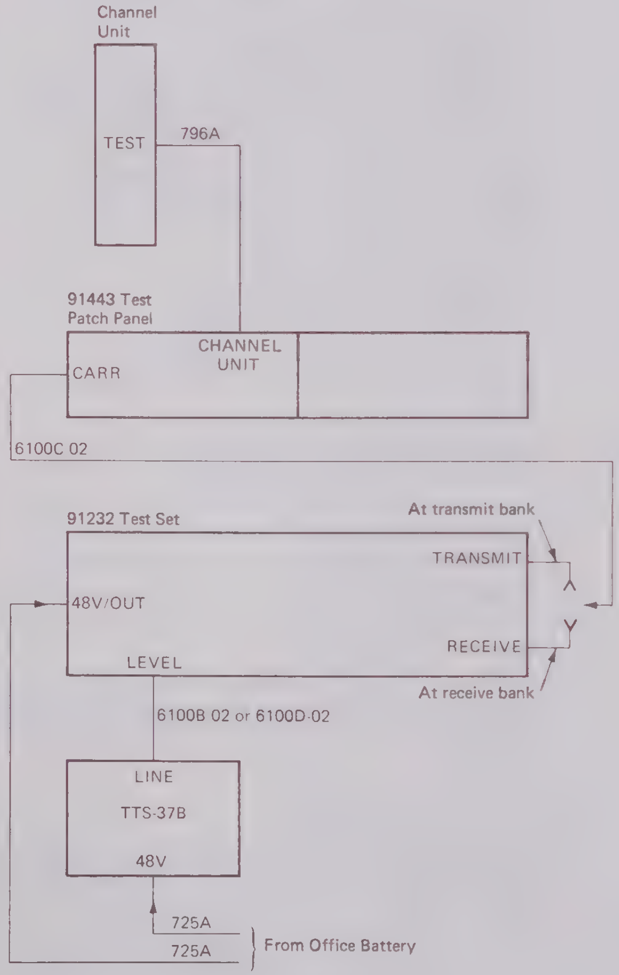
Figure 4-14. Channel Crosstalk Test with 91232 Test and Alignment Set (Sheet 1 of 2)

Description of Test. First, a 1025-Hz test tone is transmitted over the channel under test and the vf receive level is checked. Then, the test tone is transferred to two adjacent channels, one at a time, and the crosstalk level in the channel under test is measured.

"Adjacent" means in the channel sampling sequence, 1 through 24; for channel 1, the adjacent channels are 24 and 2.

Channel banks are designated "transmit" and "receive" according to the direction of transmission in the test.

Test Setup at Each Bank



CAUTION: To prevent blowing a —48V fuse by accidentally grounding the tip of the 725A Cord, connect the 725A to the load before the supply; disconnect from the supply before the load.

Step	Procedure
1	Test Setup at Each Bank
1a	Set controls on TTS-37B as follows: INPUT to 600Ω BRDG HOLD to OFF FILTER to 3 KC
1b	Connect TTS-37B to 91232 test set as shown in diagram.
1c	Connect TTS-37B and 91232 test set to office battery as shown in diagram.
2	Test Tone Calibration, 91232 Test Set at Each Bank
2a	Set TRANSMIT ATTENUATOR switch to 0 dB.
2b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress 2W 600Ω button (▲).
2c	While depressing 600Ω CALIBRATION pushbutton, adjust adjacent OSC LEVEL control for meter reading of 0.0 dBm.
2d	Release pushbutton.
3	Channel Status. Condition the channel under test and the adjacent channels for vf testing as described in paragraph 4.13.
4	Test Setup at Transmit Bank
4a	Connect channel unit under test to 91443 patch panel as shown in diagram.
4b	Connect TRANSMIT jack on 91232 test set to CARR jack on 91443 patch panel: T-R jack if channel unit is four-wire or T1-R1 jack if channel unit is two-wire.
4c	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress the applicable pushbutton.
5	Test Setup at Receive Bank
5a	Connect 91443 patch panel to channel unit under test as shown in diagram.
5b	Connect RECEIVE jack on 91232 test set to T1-R1 CARR jack on 91443 patch panel.
5c	In the RECEIVE set of CHANNEL TYPE SELECT pushbuttons, depress the applicable button.
6	VF Level at Receive Bank
6a	Set FILTER switch on TTS-37B to 3 KC.
6b	Meter reading at the receive bank should be +7 dBm (four-wire) or —3 dBm (two-wire) or as described in paragraph 4.30 according to channel unit attenuator strapping.
6c	Record level as a reference for crosstalk measurements.
6d	Set FILTER switch on TTS-37B to C MSG.
7	First Adjacent Channel at Transmit Bank
7a	Connect TRANSMIT jack on 91232 test set to CARR jack on 91443 patch panel: T-R jack if channel unit is four-wire or T1-R1 jack if channel unit is two-wire.

Figure 4-14. Channel Crosstalk Test with 91232 Test and Alignment Set (Sheet 2 of 2)

Step	Procedure
7b	In the TRANSMIT set of CHANNEL TYPE SELECT pushbuttons, depress the applicable pushbutton.
7c	Connect 91443 patch panel to channel unit as shown in diagram.
7d	At the receive bank, meter reading (dBrnc) should not exceed 25 dB higher than level (dBm) recorded in step 6c. For example, 22 dBrnc if the level is —3 dBm.
8	Second Adjacent Channel at Transmit Bank. Same as step 7.
9	Conclusion of Test
9a	Disconnect 796A cord from channel units.
9b	Restore channels to service.
9c	If other channels are to be tested, return to step 3.

5. SYSTEM ALARM TEST

5.01 A system alarm originating at the local channel bank results in a system alarm at the remote channel bank also. After a delay of at least 10 seconds, if the cause of the alarm at the local bank clears, both banks restore after an additional 5-second delay. Figure 5-1 is a procedure for verifying that the system alarm restoral at the local and remote banks is coordinated.

Figure 5-1. System Alarm Restoral Test

Description of Test. With the system operating end-to-end, a system alarm is forced and the alarm is held by depressing the LOOP pushbutton. Then, the LOOP pushbutton is released, and the time difference between restoral at each end of the system is observed. The test should be performed, in turn, on each alarm control unit of both banks.

Step	Procedure
1	Initiate System Alarm at Local Bank
1a	Create a system alarm and then complete the next two steps within 10 seconds. NOTE: In mode 1 or 3, the recommended way to initiate a system alarm is to open or short-circuit the digital receive line signal for a few seconds. If this is not convenient, or if the channel bank is mode 2, momentarily unplug the alarm control unit, A or B as applicable.
1b	Depress and release ACO pushbutton. ACO indicator should light.
1c	Depress LOOP pushbutton. Green LOOP indicator should light.
2	At the Remote Bank
2a	SYS ALM lamp and LOC indicator should be lighted.
2b	Depress and release ACO pushbutton. ACO indicator should light.
3	System Alarm Restoral
3a	When the system alarm condition has existed more than 15 seconds, release the LOOP pushbutton.
3b	After a delay of 5 seconds, the SYS ALM lamps at the local bank and remote bank should go dark within 1 second of each other.

6. TROUBLESHOOTING

6.01 The primary method of troubleshooting the 9004A channel bank is by systematic replacement of plug-in units according to observed or measured symptoms. After a unit is replaced, test as necessary to verify normal operation. If a replacement unit does not clear the trouble, remove it and plug the original unit back into the shelf before continuing with the troubleshooting.

6.02 Field repair of plug-in units is not recommended. Defective units should be returned to GTE Lenkurt as described under Factory Repair Service in Part 3.

CAUTION: If continuity checks of the channel bank shelf wiring are required, turn off the —48V power and unplug all channel units and common equipment units. There are two reasons for this precaution. One is the possibility of damaging one or many units in the shelf by shorting adjacent pins on the shelf connectors. The other is the voltage on the multimeter leads: on the higher ohm ranges, this voltage exceeds the ratings of many integrated circuits.

Common Equipment

6.03 By analysis of alarm indications with the channel banks operating in the end-to-end and looped modes, trouble usually can be isolated to one terminal or to one direction of transmission. Figure 6-1 is a summary of the alarm indications resulting from failure of a common equipment unit or a repeater unit. Figure 6-2 is a troubleshooting chart based on similar information.

Figure 6-1. Alarm Indications with Channel Bank in End-to-End and Looped Modes

Failure at Channel Bank X	Indicators Lighted (Note 1)			
	Channel Bank X		Channel Bank Y	
	End-to-End	Looped	End-to-End	Looped
Power	ALM	ALM	LOC	——
Transmit unit	REM	LOC or REM	LOC	——
Receive unit	LOC	LOC	REM	——
Repeater, X to Y direction (Note 2)	REM	——	LOC	——
Repeater, both directions	LOC	——	LOC	——

Notes:

1. Indicators. When the LOC, REM, or ALM indicator is lighted, the SYS ALM lamp will be lighted also.

2. Repeater Failure. When the channel bank is looped, the cable equalizers or pads on the back of the shelf are not included in the loop. To verify that the trouble is not in channel bank X, loop the signal as explained in paragraph 6.09.

Channel Units

See add

6.04 A defective channel unit will not be detected by the bank alarm circuits. If improper vf transmission or signaling is evident on one channel only, isolating the defective unit is obviously not difficult. However, a defective codec in one channel unit possibly could affect many or all channels. The defective unit can best be located by unplugging the channel units until the problem disappears. To ensure that other channel units are not involved, reinsert the channel units one by one, observing that the problem does not recur.

Pulsing Tests

6.05 Dial pulse signaling distortion is measured on an end-to-end basis by performance test procedures in the GTEP Sections for individual channel unit types; see Part 3.

6.06 For end-to-end testing, substituting a channel unit of the same type is a logical troubleshooting step. As an additional step, substituting a 91445 Signaling Path Test Set for the channel unit in question will enable you to detect signaling malfunctions, particularly if they are marginal or intermittent.

DC Voltage Measurements

see add

6.07 The 91425 Power Supply Unit has +5V, —5V, ~~+12V, and —12V pin jack~~ test points. With the bank fully equipped, voltages measured with a digital voltmeter should be within the following ranges.

(a) +5V or —5V to GND: 4.75 to 5.25

(b) +12V or —12V to GND: 11.88 to 12.12

6.08 With only the 91425 unit plugged into the bank, the following voltage ranges are applicable.

(a) +5V or —5V to GND: 5.0 to 5.6

(b) +12V or —12V to GND: 12.0 to 13.0

Repeatered Line

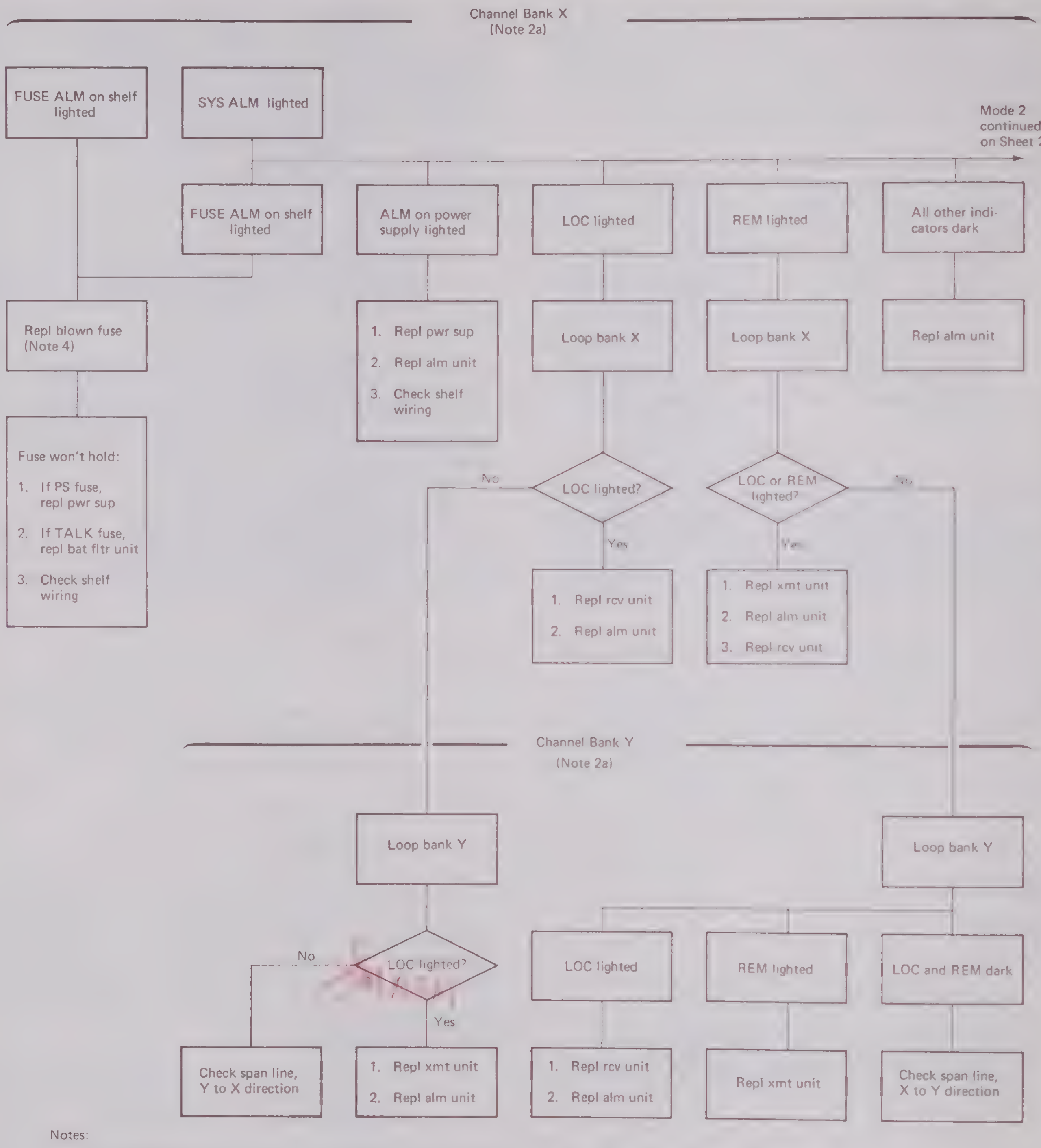
6.09 In troubleshooting a system, the repeatered line or other facility can be checked on a sectional basis by looping the DS1 or DS1C digital line signal at various patching locations. With the channel bank in system alarm condition (SYS ALM and ACO lighted), depressing the TMB HOLD pushbutton maintains the system alarm, activates the TMB function, and forces bit 2 suppression. Now, when the digital signal is looped back, one of the following indications should be observed:

(a) If the facility is good out and back, the LOC indicator will be dark, but the REM indicator will be lighted because of bit 2 suppression.

(b) If there is a failure in either direction, the LOC indicator will be lighted.

342-911-125

Figure 6-2. Troubleshooting Chart (Sheet 1 of 2)


Channel Bank X
(Note 2a)
FUSE ALM on shelf lighted
SYS ALM lighted
Mode 2 continued on Sheet 2
FUSE ALM on shelf lighted
ALM on power supply lighted
LOC lighted
REM lighted
All other indicators dark
Repl blown fuse (Note 4)
1. Repl pwr sup
2. Repl alm unit
3. Check shelf wiring
Loop bank X
Loop bank X
Repl alm unit
Fuse won't hold:
1. If PS fuse, repl pwr sup
2. If TALK fuse, repl bat fltr unit
3. Check shelf wiring
No
LOC lighted?
LOC or REM lighted?
No
Yes
Yes
1. Repl rcv unit
2. Repl alm unit
1. Repl xmt unit
2. Repl alm unit
3. Repl rcv unit
Channel Bank Y
(Note 2a)
Loop bank Y
Loop bank Y
No
LOC lighted?
Yes
LOC lighted
REM lighted
LOC and REM dark
Check span line, Y to X direction
1. Repl xmt unit
2. Repl alm unit
1. Repl rcv unit
2. Repl alm unit
Repl xmt unit
Check span line, X to Y direction

Notes:

1. Channel Banks. X and Y are arbitrary designations for the banks at opposite ends of the system.
2. Controls and Indicators.
   a. Sheet 1: LOC, REM, and SYS ALM are on the alarm units.
   b. Sheet 2: LOCAL, REMOTE, PASS, and TEST are on the syndes unit.
3. Unit Replacement. After replacing a unit, wait half a minute to see if trouble clears before continuing with troubleshooting.
4. 91424 Battery Filter Unit. Remove blown MASTER and SLAVE fuses; then replace MASTER fuse first.
5. Channel Bank Loopback. If the SYS ALM lamp is not lighted, create a system alarm by opening or short-circuiting the digital receive line signal for a few seconds. If this is not convenient, or if the channel bank is mode 2, momentarily unplug the alarm unit, A or B as applicable.

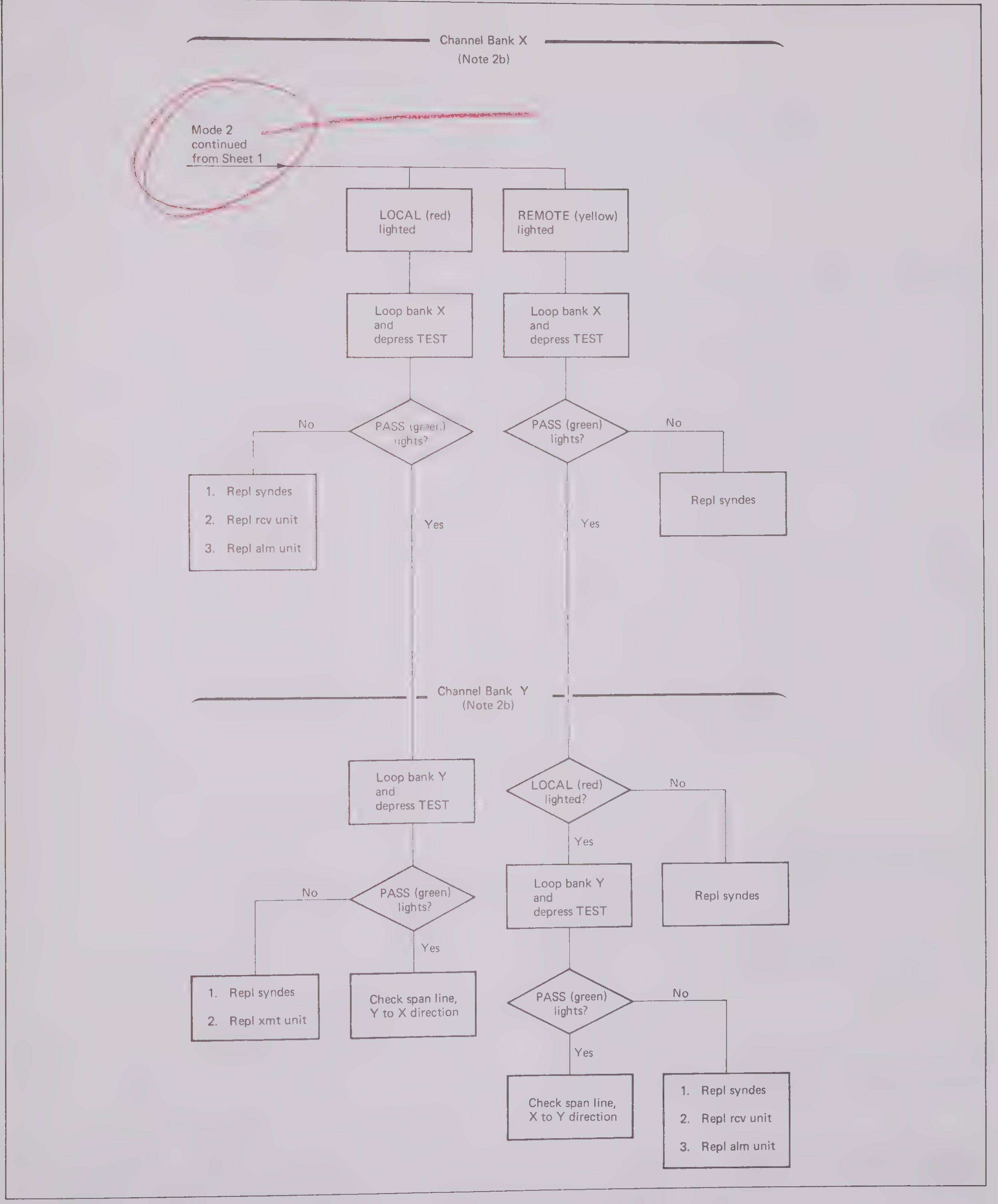
5 Channel Bank Loopback (Continued).
With the SYS ALM lamp lighted, the channel bank is looped by the following procedure:

   a. Depress and release ACO button. White ACO indicator lights.
   b. Depress LOOP button. Green LOOP indicator lights.

To remove bank from looped mode, proceed as follows:

   a. Release LOOP button. LOOP indicator goes dark.
   b. If trouble is cleared, SYS ALM lamp goes dark after a delay.
   c. ACO indicator goes dark when system alarm condition ends.

Figure 6-2. Troubleshooting Chart (Sheet 2 of 2)


Channel Bank X
(Note 2b)
Mode 2
continued
from Sheet 1
LOCAL (red)
lighted
REMOTE (yellow)
lighted
Loop bank X
and
depress TEST
Loop bank X
and
depress TEST
PASS (green)
lights?
No
Yes
PASS (green)
lights?
No
Yes
1. Repl syndes
2. Repl rcv unit
3. Repl alm unit
Repl syndes
Channel Bank Y
(Note 2b)
Loop bank Y
and
depress TEST
LOCAL (red)
lighted?
No
Yes
Repl syndes
PASS (green)
lights?
No
Yes
Loop bank Y
and
depress TEST
1. Repl syndes
2. Repl xmt unit
Check span line,
Y to X direction
PASS (green)
lights?
No
Yes
Check span line,
X to Y direction
1. Repl syndes
2. Repl rcv unit
3. Repl alm unit

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GTE LENKURT

Company Headquarters
1105 County Road
San Carlos, California 94070
Phone: 415—595-3000

Microwave & Analog Products Division
1105 County Road
San Carlos, California 94070
Phone: 415—595-3000

10727 Gateway West
El Paso, Texas 79935
Phone: 915—593-3400

Digital Products Division
One Camino de Lenkurt
Albuquerque, New Mexico 87123
Phone: 505—296-0551

Special Service Products Division
876 Ventura Street
Aurora, Colorado 80011
Phone: 303—363-7300

Fiber Optics Communications Division
1230 Charleston Road
Mt. View, California 94043
Phone: 415—962-8630

District Sales Offices
1105 County Road
San Carlos, California 94070
Phone: 415—595-3000

3015 Williams Drive
Suite 110
Fairfax, Virginia 22031
Phone: 703—698-1850

5780 Peachtree-Dunwoody Road, N.E.
Suite 145
Atlanta, Georgia 30342
Phone: 404—256-3000

120 West Eastman Street
Arlington Heights, Illinois 60004
Phone: 312—398-6700

542 Haggard Street, Suite 510
Plano, Texas 75074
Phone: 214—422-4305

GTE International Sales Office
1105 County Road
San Carlos, California 94070
Phone: 415—595-3000
Cable: GENTELINT

GTE Practices
Engineering—Plant Series
GTE LENKURT

Section 342—911—114
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91402 Two-Wire and 91404 Four-Wire E&M Channel Units

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1. GENERAL

1.01 This Section describes the 91402 Two-Wire E&M Channel Unit and the 91404 Four-Wire E&M Channel Unit. It covers applications, functional operation, installation, and maintenance of the units. A circuit diagram of the channel units is included in this Section.

1.02 These channel units are plug-in modules of the 9004A PCM Channel Bank, which provides up to 48 channels. Refer to Section 342-911-111 for basic information regarding channel units and detailed systems information. Section 342-911-112 provides installation, testing, and maintenance information.

1.03 The equipment described in this Section is the latest model as of the publication date. Later models are capable of greater application or performance than earlier models. A later model supersedes an earlier model and may always be substituted for an earlier model of the same type number. Necessary information pertaining to earlier models is retained in the applicable part of this Section.

▶ 1.04 This Section is reissued to restrict the back-to-back and PLR signaling options to a type I interface. Mainly, this affects figures 6E and 6F and figure 11. Marginal arrows identify significant changes. Remove the previous issue of this Section from the binder or microfiche file and replace it with this issue.◀

2. APPLICATIONS

General

2.01 The 91402 and 91404 channel units provide intertoll grade vf transmission and E&M signaling through a type I, II, or III interface. The 91402-01 provides a 900-ohm + 2.15-μF drop impedance; the 91402-02 provides a 600-ohm + 2.15-μF drop impedance; the 91404 provides 600-ohm drop impedances. The two-wire units include an NBO circuit and A and B leads. In addition, the 91402 and 91404 include a mounting provision for the optional C lead (Code A) subassembly. Both channel unit types feature a front panel mounted, multipin TEST connector, BUSY indicator LED, and a NORM/BUSY switch. Refer to figure 1, which shows the vf transmission levels, signaling interface, and special circuits of the 91402-01/02 and the 91404 units.

2.02 The internal vf levels on the 91402 and 91404 units are factory set. However, the internal precision attenuators must be strapped to coordinate the drop levels with the preset internal levels of the units. This operation is performed at the time of installation according to the trunk loss required. Figure 2 shows factory strapping of the attenuators in the 91402 and 91404 units. As shown in figure 2A, the attenuators in the 91402 are factory strapped for 4.5 dB (transmit) and 3 dB (receive). In figures 2B and 2C, the attenuators in the 91404 are shown strapped for a loss of 1.5 dB, which assumes zero loss in the office wiring. Attenuator strapping plus office wiring must produce a total loss of 1.5 dB. For example, a loss of 0.5 dB in office wiring would require attenuator strapping for an additional loss of 1.0 dB.

VF Levels, 91402

2.03 The 91402 units include 6.3-dB attenuators, adjustable in 0.1-dB steps, in the transmit and receive paths. The transmit attenuator in the 91402 is factory strapped for 4.5 dB of attenuation, which is the proper compensation for a transmit drop level of 0 dBm. Refer to figure 1, which shows the transmit drop level range of the 91402. To compensate for a drop level in this range, use the 0-dBm level and 4.5-dB attenuator value as reference. For example, if the required drop level is −2 dBm, remove 2 dB of attenuation from the transmit attenuator.

2.04 The receive path attenuator is factory strapped for 3 dB of attenuation to provide a receive drop level of −3.0 dBm and is increased or decreased depending on the trunk loss required. Refer to figure 1, which shows the receive path level range of the 91402.

VF Levels, 91404

2.05 Transmit Level, Nontandem. For primarily nontandem applications, Models 1 and 2 of the 91404 include transmit and receive attenuators which can provide up to 6.3 dB of loss in 0.1-dB steps. Nontandem drop levels over a range of −17.5 to −11.2 dB can be compensated when the tandem attenuators (paragraphs 2.07 and 2.08) are strapped for 0 dB. Factory strapping is for 1.5-dB attenuation which, with 0-dB of-

Figure 1. Channel Unit Features

Channel Unit	Impedance, Ohms	Drop Levels, dBm		Special Features	Signaling Interface Options
		Transmit	Receive		
91402-01 Models 1 and 2	900 + 2.15 μF	−4.5 to +1.8 $\boxed{1}$	0 to −6.3 $\boxed{1}$	C Lead (Code A) NBOC $\boxed{5}$ A and B Leads, 80 mA Remote busy (On Model 2) $\boxed{6}$	Type I, II, or III Std Type I Back-To-Back (Model 1), PLR (Model 2)
91402-02 Models 1 and 2	600 + 2.15 μF				
91404, Model 1	600	−17.5 to −11.2 $\boxed{1}$	+8.5 to +2.2 $\boxed{1}$	C Lead (Code A)	
		−4.5 to +1.8 $\boxed{2}$	−1.5 to −7.8 $\boxed{2}$		
		+4.5 to +10.8 $\boxed{3}$	−14.5 to −20.8 $\boxed{3}$		
91404, Model 2	600	−17.5 to +1.6 $\boxed{4}$	+8.5 to −10.6 $\boxed{4}$	C Lead (Code A)	
		+4.5 to +10.8 $\boxed{3}$	−14.5 to −20.8 $\boxed{3}$	Remote busy $\boxed{6}$	

Notes:

$\boxed{1}$ When the units are used with these levels, make internal level compensation with the 6.3-dB transmit and receive attenuators. On 91404-M1, also strap the tandem attenuators for 0 dB.

$\boxed{2}$ Drop levels in this range are internally compensated by strapping the 13-dB (transmit) and 10-dB (receive) attenuators and then by making additional adjustments, if necessary, with the 6.3-dB pads. The 13- and 10-dB attenuators are used for tandem switching applications, i.e., #3 EAX when −3 dBm/−3 dBm interface is desired; for #4A XB switch level of −2 dBm/−2 dBm; also, for non-tandem special applications such as switchboards, testboards, and MTPs in a #3 EAX.

$\boxed{3}$ Tandem drop levels in this range are internally compensated by first strapping the 22- or 23-dB tandem attenuators and then by making additional adjustments, if necessary, with the 6.3-dB attenuators.

$\boxed{4}$ This range, continuous in 0.1-dB steps, is obtained by strapping tandem attenuators for 12.8, 6.4, or 0 dB and making additional adjustments with the 6.3 dB pads.

$\boxed{5}$ Network buildout capacitance (NBOC) is strappable from 0 to 0.126 μF in 0.002-μF steps.

$\boxed{6}$ Transmission of a forced busy condition to the far terminal is enabled by strap selection and use of the busy switch.

fice loss, gives a transmit level of −16 dBm. To adjust for any other level within the 6.3-dB range, use the −16 dBm and 1.5-dB attenuator loss as a reference. For example, if the required transmit drop level is −13 dBm, strap in an additional 3 dB of attenuator loss. This will result in a total loss of 4.5 dB (1.5 + 3 dB) in the transmit path. Refer to figure 3 which shows the fixed transmission level points (TLP) as well as typical drop levels and the associated attenuator strapping.

2.06 Receive Level, Nontandem. The receive path attenuator is also factory strapped for 1.5 dB and increased or decreased depending on the required trunk loss. Refer to figure 1, which shows the receive path level range for nontandem applications.

2.07 Special/Tandem Application, Model 1. Model 1 of the 91404 includes tandem attenuators which can be strapped for 0, 13, or 22 dB of attenuation in the transmit path and for 0, 10, or 23 dB of attenuation in the receive path. The 13-dB transmit and 10-dB receive attenuators are used to provide special level compensation for a testboard, switchboard, or tandem switch with drop levels ranging from −4.5 to +1.8 dBm (transmit) and −1.5 to −7.8 dBm (receive). The 22- and 23-dB attenuators are used to compensate for tandem drop levels ranging from +4.5 to +10.8 dBm (transmit) and −14.5 to −20.8 dBm (receive). With the tandem attenuators strapped into the transmit and receive paths, additional adjustments in 0.1-dB steps can then be made with the 6.3-dB attenuators.

2.08 Special/Tandem Application, Model 2. Model 2 of the 91404 includes strap-selectable tandem attenuators similar in application to those on the Model 1 but modified to provide expanded ranges of attenuation in the transmit and receive paths. Tandem attenuators can be strapped for 0, 6.4, 12.8, or 22 dB of attenuation in the transmit path, and 0, 6.4, 12.8, or 23 dB of attenuation in the receive path. Used in conjunction with the 6.3-dB attenuators, the tandem attenuators can compensate for transmit drop levels ranging from −17.5 to +1.6 dBm and from +4.5 to +10.8 dBm and for receive drop levels ranging from +8.5 to −10.6 dBm and from −14.5 to −20.8 dBm.

2.09 A back-to-back or PLR level arrangement is shown in figure 4. In this arrangement, a crosstalk advantage is obtained by strapping both channel units for +7 dBm in each direction.

2.10 In a tandem back-to-back or PLR application for transmit/receive levels of +7/−16 dBm, the unit is strapped to add a 22-dB attenuator in the transmit path and a 23-dB attenuator in the receive path. The reason for having a 22-dB transmit attenuator (instead of 23 dB) is to provide correct level coordination at a No. 3 EAX or No. 4 ESS digital switch when the remote end is terminated at a TP2 office. For other applications, the 1-dB difference can be made up in the 6.3-dB transmit attenuator.

Signaling

2.11 By means of strapping plugs, the 91402 and 91404 channel units can be arranged as a standard E&M unit or as a back-to-back or PLR unit. The on-hook/off-hook conditions for the standard E&M unit are as follows:

(a) Type I or III interface: open/ground on the E lead and ground/battery on the M lead.

(b) Type II interface: open/closed on the E lead and open/battery on the M lead.

Figure 2. Attenuator Strapping on the 91402 and 91404

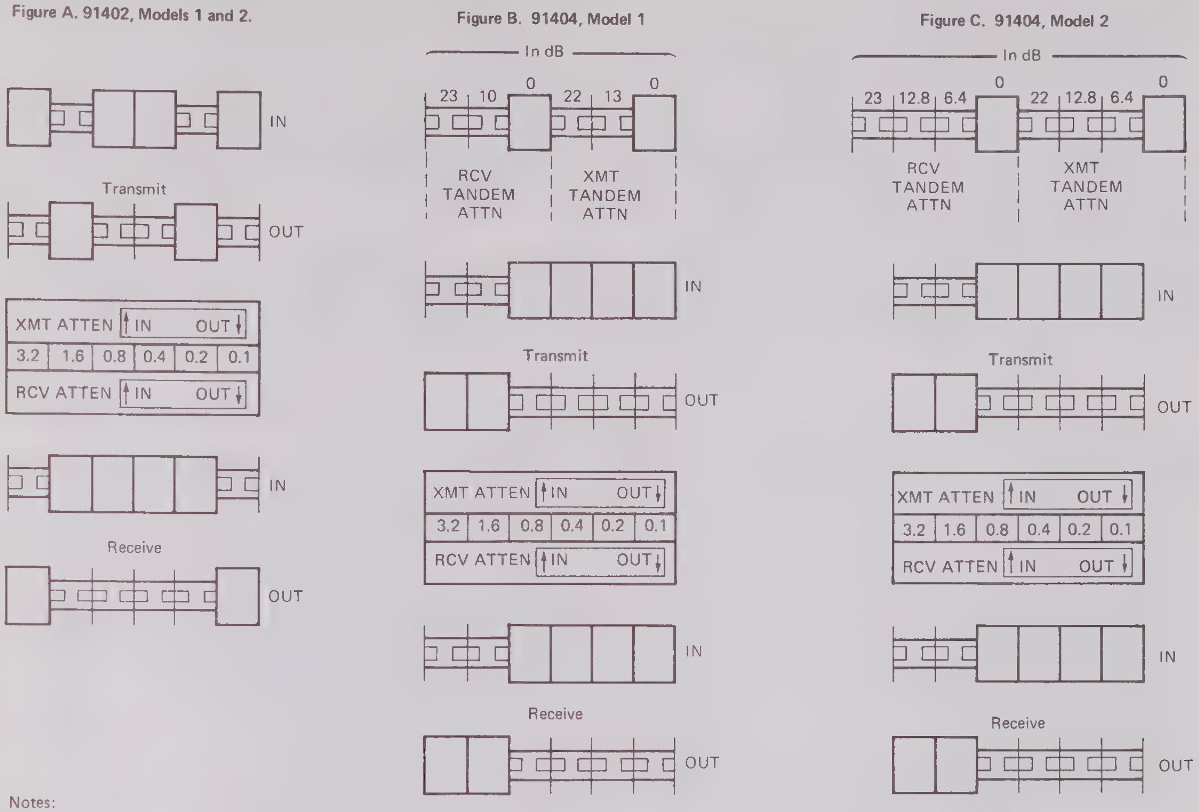


Figure A. 91402, Models 1 and 2.

Figure B. 91404, Model 1

Figure C. 91404, Model 2

IN
Transmit
OUT
XMT ATTEN
IN
OUT
3.2
1.6
0.8
0.4
0.2
0.1
RCV ATTEN
IN
OUT
IN
Receive
OUT
In dB
23
10
0
22
13
0
RCV TANDEM ATTN
XMT TANDEM ATTN
In dB
23
12.8
6.4
0
22
12.8
6.4
0

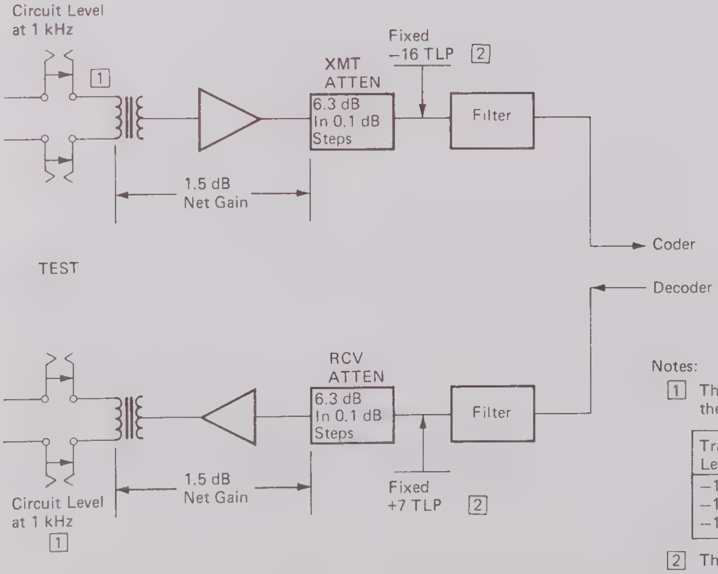
Notes:

1. Attenuator Strapping, 91402. The XMT ATTEN is shown strapped for 4.5 dB of attenuation; the RCV ATTEN is shown strapped for 3.0 dB. The attenuator value is the sum of the values in line with the plugs in the IN position.

2. Attenuator Strapping, 91404. The XMT and RCV ATTENs are shown strapped for 1.5 dB each. The attenuation value is the sum of the values in line with the plugs in the IN position. The XMT and RCV TANDEM ATTNs are shown strapped for 0 dB. The value of tandem attenuation is the value of the position with the strapping plug, e.g., the transmit tandem attenuator can provide one of the following values: 0, 13, or 22 dB. (Model 1), or 0, 6.4, 12.8 or 22 dB (Model 2).

3. Extracting Tool. When strapping attenuators on the 91402 and 91404, the GTE Lenkurt extracting tool, part number 020-56788-01, may be used to insert or remove strapping plugs.

Figure 3. Typical Attenuator Settings for 91404 Trunk Circuit Applications



Circuit Level at 1 kHz
1
Fixed
−16 TLP
2
XMT ATTEN
6.3 dB In 0.1 dB Steps
Filter
1.5 dB Net Gain
Coder
TEST
Decoder
RCV ATTEN
6.3 dB In 0.1 dB Steps
Filter
1.5 dB Net Gain
Fixed
+7 TLP
2
Circuit Level at 1 kHz
1

Notes:

1. The following shows typical transmit and receive circuit levels and the associated attenuator strapping:

Transmit Level	Transmit Attenuator	Receive Level	Receive Attenuator
−16.5 dBm	1.0 dB	+7.5 dBm	1.0 dB
−16 dBm	1.5 dB	+7 dBm	1.5 dB
−13 dBm	4.5 dB	+4 dBm	4.5 dB

2. This TLP is not accessible for measurement purposes.
3. Tandem attenuators are strapped for 0 dB and are not shown.

Figure 4. Tandem 91404 VF Circuits

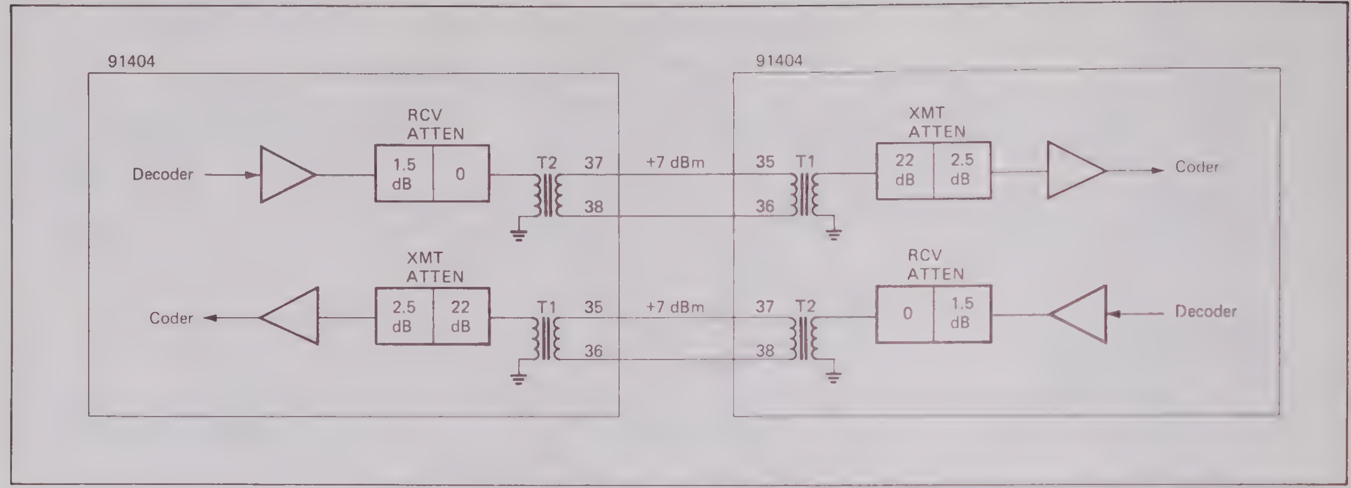
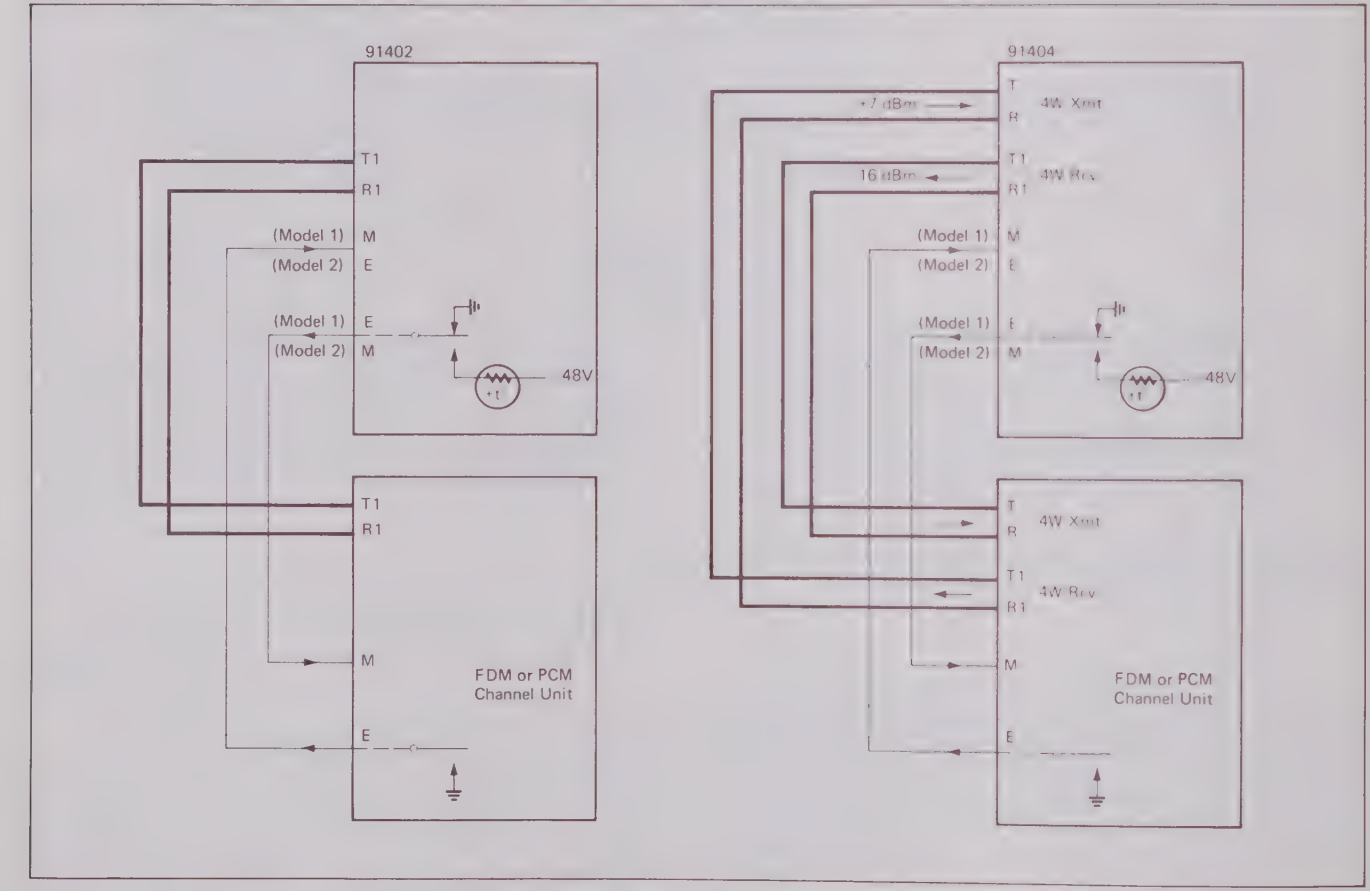

91404
RCV
ATTEN
Decoder
1.5
dB
0
T2
37
38
XMT
ATTEN
Coder
2.5
dB
22
dB
T1
35
36
+7 dBm
+7 dBm
91404
XMT
ATTEN
35
T1
36
22
dB
2.5
dB
Coder
RCV
ATTEN
37
T2
38
0
1.5
dB
Decoder

Figure 5. Tandem Channel Units with Type I Signaling Interface


91402
T1
R1
(Model 1)
M
(Model 2)
E
(Model 1)
E
(Model 2)
M
+t
48V
T1
R1
M
E
FDM or PCM
Channel Unit
91404
T
+7 dBm
R
4W Xmt
T1
16 dBm
R1
4W Rcv
(Model 1)
M
(Model 2)
E
(Model 1)
E
(Model 2)
M
+t
48V
T
R
4W Xmt
T1
R1
4W Rcv
M
E
FDM or PCM
Channel Unit

2.12 At a trunk circuit interface, the 91402 or 91404 channel unit is strapped as a standard E&M unit with type I, II, or III interface. At a tandem point, the channel unit, with appropriate strapping for conditioning of the E and M leads, can be connected with the E&M channel unit of another fdm or pcm carrier system. The preferred tandem interface is type I, and the on-hook/off-hook conditions of the tandem unit are ground/battery on the signaling output and open/ground on the signaling input. The arrangement requires a back-to-back connection of a Model 1 unit or a PLR connection of a Model 2 unit, as follows:

(a) Model 1 in Tandem. Figure 5 illustrates the back-to-back connections of a Model 1 channel unit at a tandem point. The E and M leads of the back-to-back unit are externally wired to the M and E leads, respectively, of the standard E&M unit.

(b) Model 2 in Tandem. A tandem interface of a Model 2 channel unit is made with a PLR connection to the E&M unit. The units are externally connected E-lead to E-lead and M-lead to M-lead. The crossover (E to M and M to E) is an internal, strap-selectable function of the Model 2 unit. The E&M/PLR strapping plug and routing of the E and M signals are shown in figure 6G.

NOTE: The 91402 and 91404 cannot be used on channels that require separate A and B signaling; for example, most foreign-exchange circuits. These applications require the 91407 Four-Wire Tandem Channel Unit, which has two sets of E&M leads for the A and B signaling channels.

VF Drop, 91402

2.13 Two-Wire Hybrid. This is a bridge circuit that includes a transformer and two operational amplifiers. The hybrid is balanced by an internal compromise network. The 91402 meets minimum return loss requirements of 28-dB ERL and 20-dB SRL.

2.14 Midpoint Capacitor. The 91402 has a midpoint capacitor across the A and B leads. If the external circuit includes this capacitance, the 91402 capacitor is strapped out.

2.15 NBO Capacitance. The 91402 units include up to 0.126 μF of strappable network buildout (NBO) capacitance in 0.002-μF steps to compensate for office wiring capacitance. The strap positions are marked in nanofarads (nF) on the unit (2 nF = 0.002 μF).

Optional C-Lead Subassembly

2.16 The 91402 and 91404 units can be arranged with an optional C-lead subassembly, 087-56916-01. This subassembly is mounted on the component side of the units and used by trunks which indicate a busy condition (off-hook) via a grounded C lead.

---

3. FUNCTIONAL CIRCUIT OPERATION

3.01 For a basic explanation of channel units and detailed system information, refer to Section 342-911-111. While reading the following description, refer to figure 6, which shows the vf and signaling circuits of the 91402 and the 91404 channel units.

VF Signals

3.02 91402 Channel Unit. The 91402 converts two-wire vf circuits to four-wire vf circuits via the two- to four-wire hybrid. Included in the hybrid is a strappable NBO circuit with up to 0.126 μF in 0.002-μF steps. The unit provides level coordination attenuators in the transmit and receive paths, which are strapped according to the required trunk loss.

3.03 91404 Channel Unit. Transmit and receive vf signal flow in the 91404 is similar to the 91402 except for the following differences: the 91404 is a four-wire unit with separate transmit and receive drop circuits, and it has tandem attenuators in addition to the 6.3-dB attenuators, which permit interfacing tandem, nontandem, and special drop levels.

Signaling

3.04 The 91402 and 91404 units have identical E&M signaling circuits. These circuits are arranged by strapping options into type I, II, or III standard E&M or type I back-to-back or PLR signaling circuits.

3.05 Transmit Signaling, Type I. In a standard type I signaling format, the M-lead circuit is arranged for ground (on-hook) and battery (off-hook) conditions via straps B and D. When the drop circuit goes off-hook, battery is placed on the M lead, which causes the transmit signaling circuit to output a logic level 0. This is inverted by inverter 1 to logic level 1 which switches gate 2 via strap B, causing the BUSY LED to light. In addition, the logic level 1 is routed to the signal transmit (Sig-x) port of the coder, which converts the M-lead states to pcm signals and transmits them during the channel unit time slot to the common equipment via the PCMT bus.

3.06 In a Model 1 unit arranged for the back-to-back option, operation is essentially the same except the on-hook/off-hook transmit signaling states are open/ground. When options C and A are strapped, they provide the proper interface voltage and noninverting function, respectively. In a Model 2 unit arranged for the PLR option, the on-hook/off-hook states are also open/ground, but the E lead is the transmit signaling lead.

3.07 Receive Signaling, Type I. In a standard type I signaling format, the E-lead circuit is arranged for open (on-hook) and ground (off-hook) conditions via straps F, H, and J. Receive signaling information enters the channel unit via the PCMR′ lead and is processed by the decoder, which provides a logic level 1 output on its Sig-r lead for an off-hook condition. The logic level is routed through gate 4, causing the receive signaling circuit to energize the E relay, grounding the E lead. The output of gate 4 also switches gate 2 output to logic 0, causing the BUSY LED to light.

3.08 In a Model 1 unit arranged for the back-to-back option or a Model 2 unit arranged for the PLR option, the on-hook/off-hook receive signaling states are ground/battery on the E lead (Model 1) or M lead (Model 2). Straps F, G, and L connect internal resistance battery to the normally-open contact of the E relay; strap I connects the normally-closed contact of the relay to ground.

Trunk Make Busy (TMB)

3.09 When a system alarm occurs, the TMB1′ lead is immediately grounded and Sig-r is forced to logic level 0; the TMB2′ lead is grounded 2 seconds later. Straps P, O, N,

Figure 6. 91402 and 91404 Channel Units, Circuit Diagram (Sheet 1 of 4)

Figure A. 91402 VF Circuits

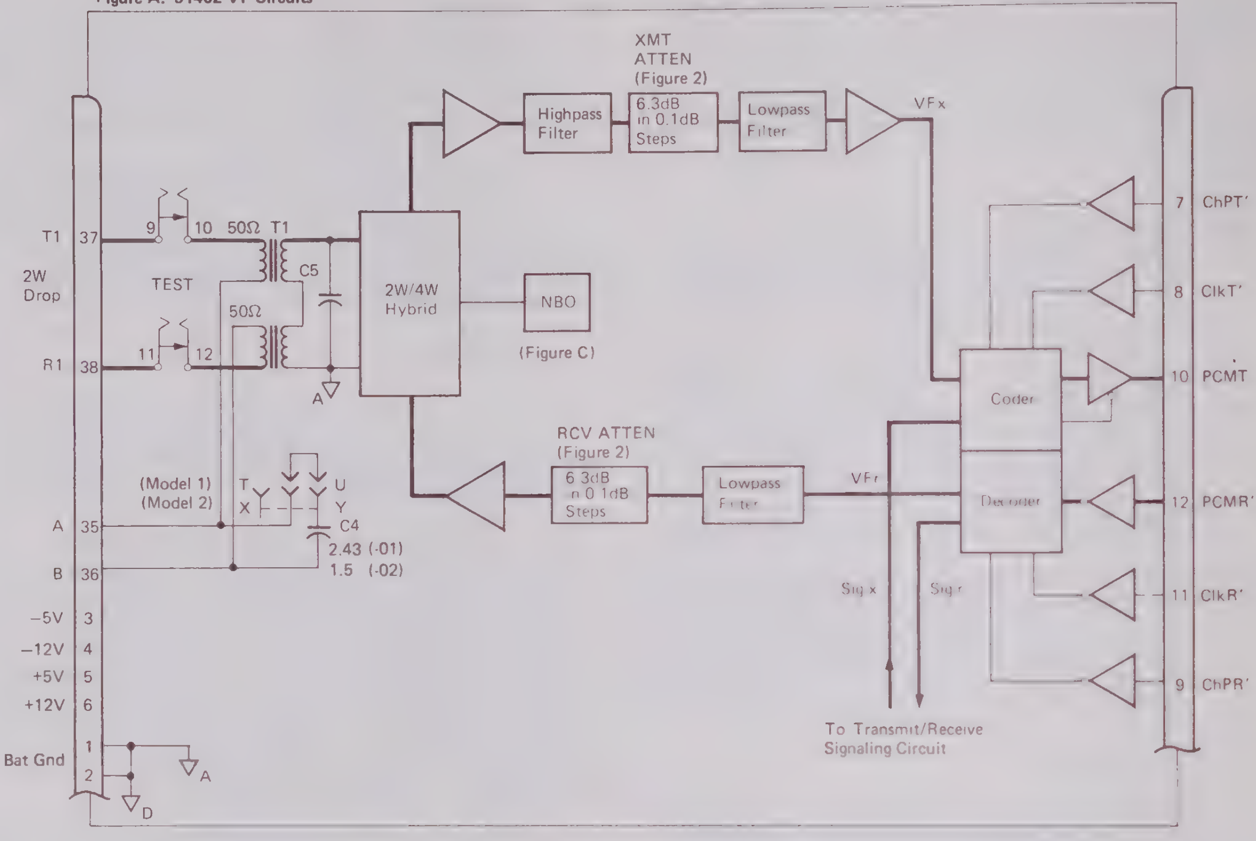

XMT
ATTEN
(Figure 2)
Highpass Filter
6.3dB in 0.1dB Steps
Lowpass Filter
VFx
T1
37
9
10
50Ω
T1
2W
Drop
TEST
C5
2W/4W Hybrid
NBO
(Figure C)
50Ω
R1
38
11
12
A
RCV ATTEN
(Figure 2)
6.3dB in 0.1dB Steps
Lowpass Filter
VFr
(Model 1)
(Model 2)
T
X
U
Y
C4
2.43 (-01)
1.5 (-02)
A
35
B
36
–5V 3
–12V 4
+5V 5
+12V 6
Bat Gnd
1
2
A
D
Sig x
Sig r
To Transmit/Receive Signaling Circuit
Coder
Decoder
7 ChPT'
8 ClkT'
10 PCMT
12 PCMR'
11 ClkR'
9 ChPR'

Figure B. 91404 VF Circuits

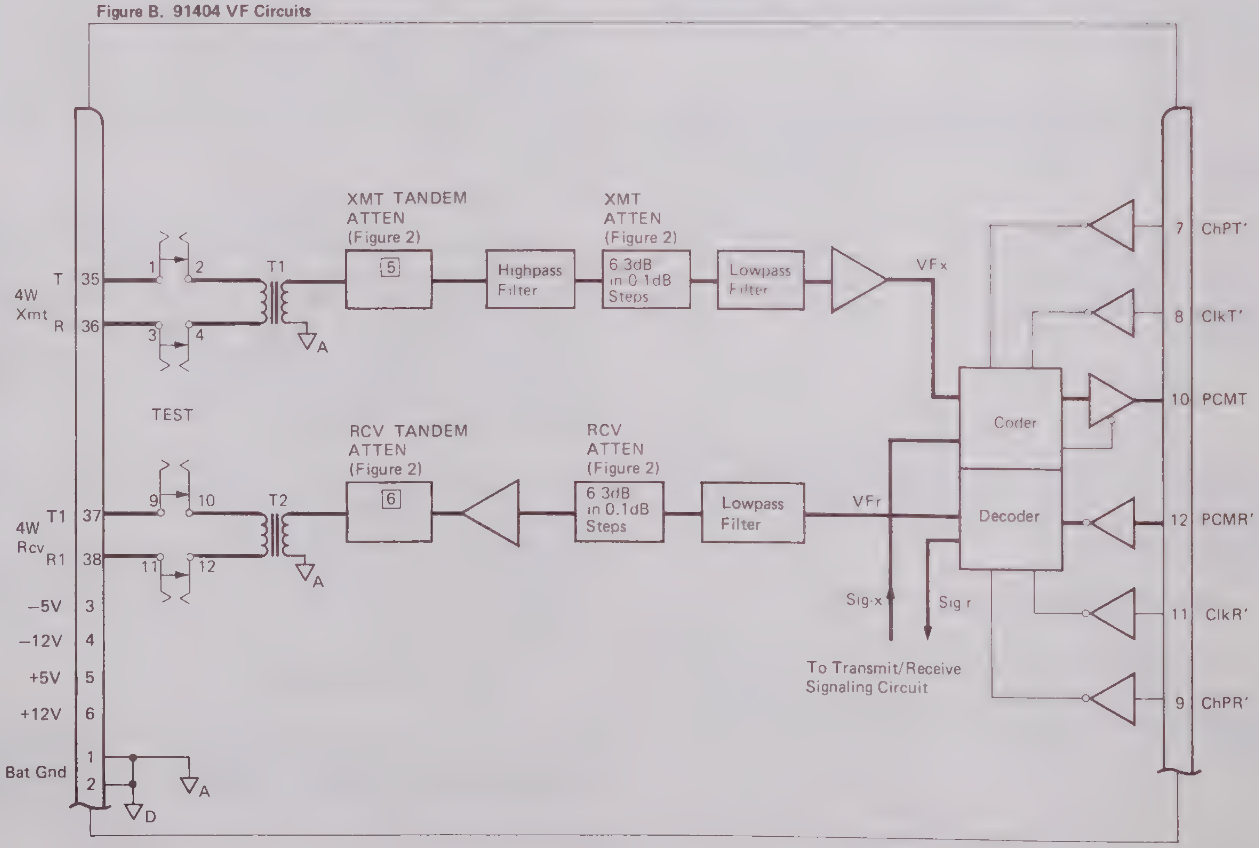

XMT TANDEM
ATTEN
(Figure 2)
5
Highpass Filter
XMT
ATTEN
(Figure 2)
6.3dB in 0.1dB Steps
Lowpass Filter
VFx
4W
Xmt
T 35
R 36
1
2
3
4
T1
A
TEST
RCV TANDEM
ATTEN
(Figure 2)
6
RCV
ATTEN
(Figure 2)
6.3dB in 0.1dB Steps
Lowpass Filter
VFr
4W
Rcv
T1 37
R1 38
9
10
11
12
T2
A
–5V 3
–12V 4
+5V 5
+12V 6
Bat Gnd
1
2
A
D
Sig x
Sig r
To Transmit/Receive Signaling Circuit
Coder
Decoder
7 ChPT'
8 ClkT'
10 PCMT
12 PCMR'
11 ClkR'
9 ChPR'

Figure 6. 91402 and 91404 Channel Units, Circuit Diagram (Sheet 2 of 4)

Figure C. NBO Network on 91402 (values in μF)

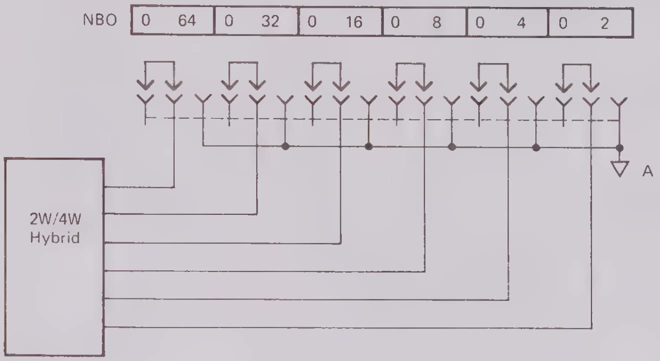

NBO
0 64
0 32
0 16
0 8
0 4
0 2
A
2W/4W
Hybrid

Figure D. 91402 and 91404 Model 1 Signaling Circuits

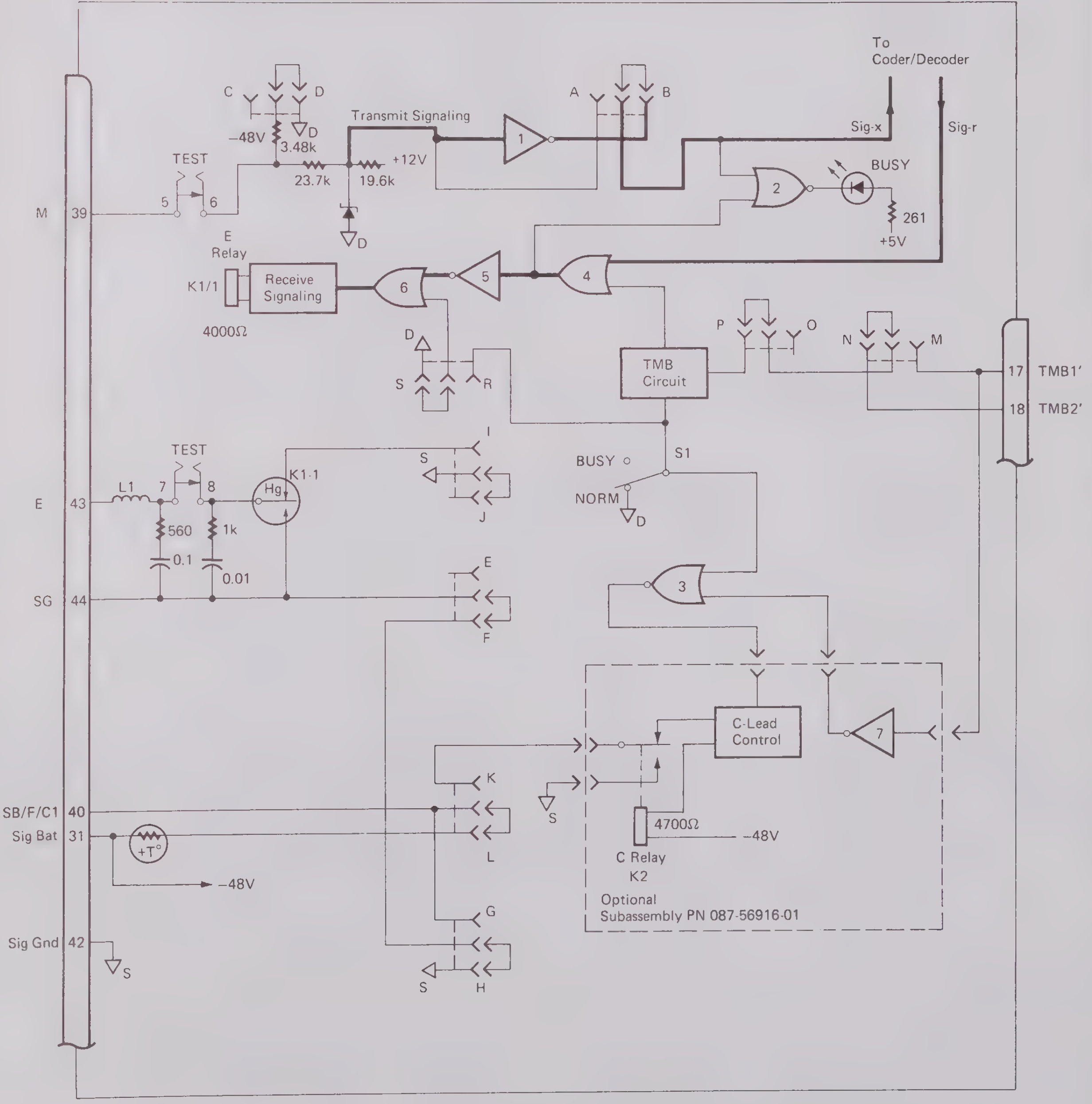

To
Coder/Decoder
C
D
A
B
Transmit Signaling
−48V
3.48k
D
+12V
23.7k
19.6k
1
Sig-x
Sig-r
TEST
5
6
2
BUSY
261
+5V
M
39
D
E
Relay
K1/1
Receive
Signaling
6
5
4
4000Ω
D
S
R
P
O
N
M
TMB
Circuit
17
TMB1′
18
TMB2′
I
S
J
TEST
BUSY
S1
NORM
D
E
43
L1
7
8
Hg
K1-1
560
1k
0.1
0.01
SG
44
E
F
3
K
SB/F/C1
40
Sig Bat
31
+T°
−48V
L
S
C-Lead
Control
7
4700Ω
−48V
C Relay
K2
Optional
Subassembly PN 087-56916-01
G
Sig Gnd
42
S
S
H

Figure 6. 91402 and 91404 Channel Units, Circuit Diagram (Sheet 3 of 4)

Figure E. Strap Options of Model 1 Units.

Option			Strap	
Transmit Signaling, M lead	Type I, III Std	On-hook/off-hook = ground/battery	B,D	*
	Type I Back-to-Back	= open/ground	A,C	
	Type II Std	= open/battery (M/SB loop)	B,D	
Receive Signaling, E lead	Type I, II Std	On-hook/off-hook = open/ground	F,H,J	*
	Type I Back-to-Back	= ground/battery	F,G,I	
	Type II Std	= open/closed (E/SG loop)	E,H,J	
Internal battery on SB lead	Optional C-lead circuit not equipped (or equipped but not used).		L	*
External battery on F lead	Optional C-lead circuit equipped but not used		K/L to PRK [1]	
	Optional C-lead circuit not equipped		K	
C-lead function	Optional C-lead circuit equipped		K	
A and B leads	External mid-point capacitor		T	
(91402 only)	Internal mid-point capacitor		U	*
TMB function for E lead	Immediate on-hook		O,N	
	Two-seconds on-hook before off-hook		P,N	*
	Immediate off-hook		P,M	
Busy switch function for trunk usage	Unit not using C1 lead	One-way outgoing	S	*
		One-way incoming	R	
		Two-way	S	
		Tandem	R	
	Unit using C1 lead	One-way outgoing	R	
		One-way incoming	R	
		Two-way	R	
		Tandem	R	

Figure F. Strap Options of Model 2 Units

Option				Strap	
Transmit Signaling	M lead	Type I, III Std	On-hook/off-hook = ground/battery	B,D	*
	E lead	Type I, PLR	= open/ground	A,C [4]	
	M lead	Type II Std	= open/battery (M/SB loop)	B,D	
Receive Signaling	E lead	Type I, III Std	On-hook/off-hook = open/ground	F,H,J	*
	M lead	Type I PLR	= ground/battery	F,G,I [4]	
	E lead	Type II Std	= open/closed (E/SG loop)	E,H,J	
Internal battery on SB lead		Optional C-lead circuit not equipped (or equipped but not used).		L,N	*
External battery on F lead				K,N	
C-lead function		Optional C-lead circuit equipped		L,M	
A and B leads		External mid-point capacitor		X	
(91402 only)		Internal mid-point capacitor		Y	*
TMB function for E lead		Immediate on-hook		U,V	
		Two-seconds on-hook before off-hook		U,W	*
		Immediate off-hook		T,W	
Busy switch strapping [3]		Local busy (sends busy to local end)	In	S	*
			Out	R	
		Remote busy (sends busy to far end)	In	O	
			Out	P	*

Factory Strapping *

Notes:

[1] The 91402 Model 1 is not equipped with a PRK (park) position. In the event that the unit is arranged in this manner, store the K/L option strap externally.

2 Strapping Plug. When strapping options on the 91402 or 91404, use a GTE Lenkurt extracting tool, part number 020-56788-01, to insert or remove strapping plugs.

[3] Some typical applications of local/remote busy strapping are listed in figure 7.

[4] On 91402 Model 2 or 91404 Model 2, insert the E&M/PLR strapping plug in E&M position for standard signaling interface Type I, II, or III. At a tandem point, insert the strapping plug in PLR position in one channel unit of a tandem-connected pair.

[5] Attenuation of 0, 13, or 22 dB in Model 1; and 0, 6.4, 12.8, or 22 dB in Model 2.

[6] Attenuation of 0, 10, or 23 dB in Model 1; and 0, 6.4, 12.8, or 23 dB in Model 2.

Figure 6. 91402 and 91404 Channel Units, Circuit Diagram (Sheet 4 of 4)

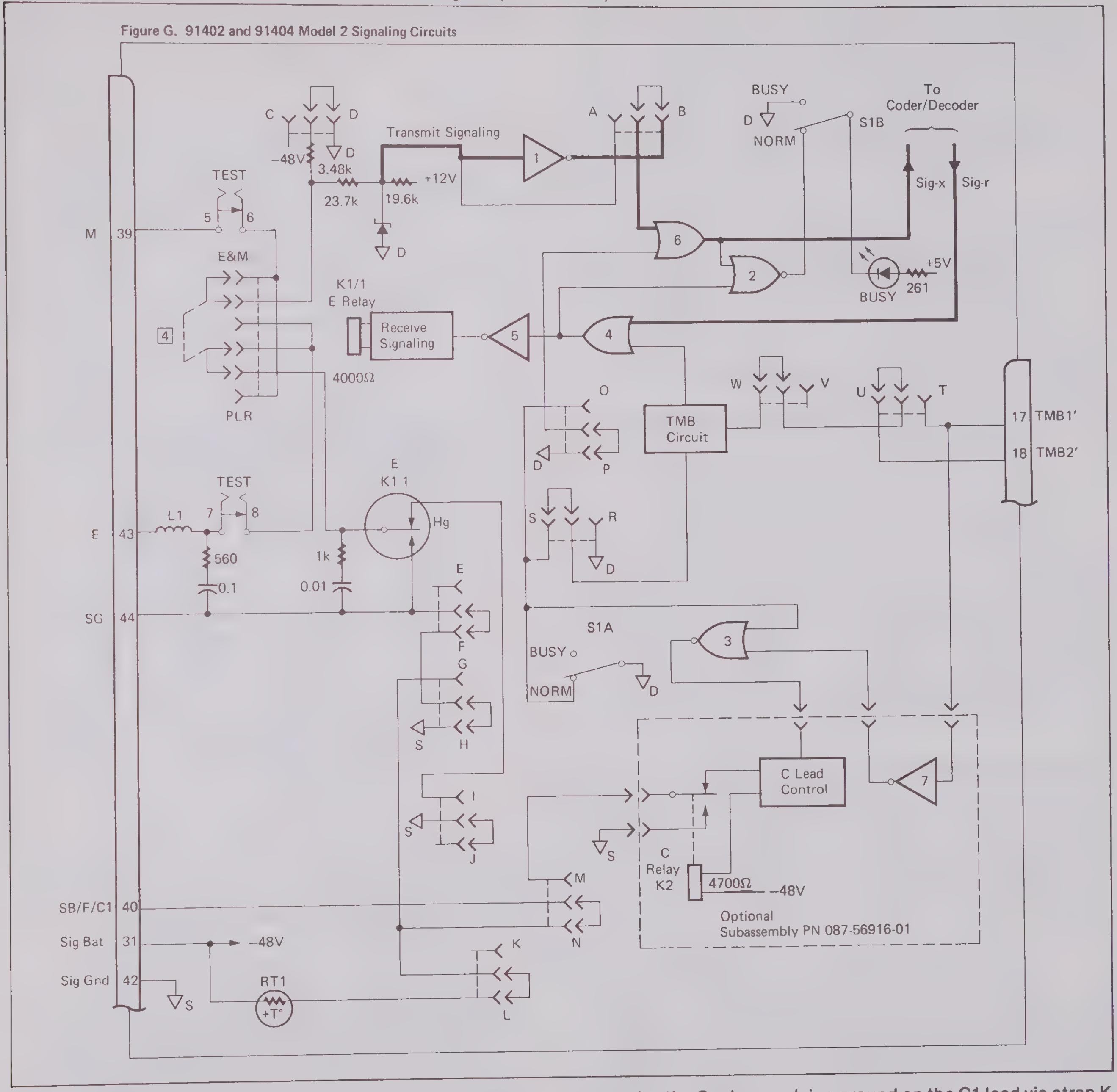


Figure G. 91402 and 91404 Model 2 Signaling Circuits

C
D
−48V
3.48k
23.7k
19.6k
+12V
Transmit Signaling
1
A
B
BUSY
D
NORM
S1B
To Coder/Decoder
Sig-x
Sig-r
TEST
5
6
M
39
E&M
4
PLR
6
2
+5V
261
BUSY
K1/1
E Relay
Receive Signaling
4000Ω
5
4
O
P
W
V
U
T
TMB Circuit
17 TMB1′
18 TMB2′
TEST
L1
7
8
E
43
560
0.1
E
K1 1
Hg
1k
0.01
S
R
SG
44
E
F
G
H
S1A
BUSY
NORM
3
I
J
C Lead Control
7
C Relay K2
4700Ω
−48V
Optional Subassembly PN 087-56916-01
M
N
SB/F/C1
40
Sig Bat
31
−48V
Sig Gnd
42
RT1
+T°
K
L

and M (in Model 1) or W, V, U, and T (in Model 2) are used to select the required TMB function. For example, when straps P and N (Model 1) or W and U (Model 2) are selected, and the unit is not equipped with a C-lead control, a system alarm ground on TMB1′ has no effect, but gate 4 is switched to logic level 0 by Sig-r. Two seconds after alarm, ground is applied via TMB2′ and straps N and P (Model 1) or W and U (Model 2) to the TMB circuit. This circuit outputs a logic level 1 to switch gate 4 to a logic level 1. Gate 4 switches gate 2, causing the BUSY LED to light. The output of gate 4 is also inverted, causing the receive signaling circuit to energize the E relay, which grounds (busies) the E lead.

3.10 C-Lead Control. When system alarm occurs in a unit with the optional C-lead control subassembly, ground on TMB1′ is inverted by inverter 7, switching the output of gate 3 to a logic level 0. This causes the C-lead control circuit to energize the C relay, applying ground on the C1 lead via strap K (Model 1) or M (Model 2). If the channel unit is busy when system alarm occurs, the C-lead control circuit senses the grounded C1 lead. The control circuit waits until 50 ms after on-hook (release of the C lead by the switching equipment) before applying ground on the C lead via the C relay. The C lead remains grounded for the duration of the alarm.

NORM/BUSY Switch

3.11 Models 1 and 2 of the 91402 and 91404 channel units are equipped with a NORM/BUSY switch. The Model 1 switch is used in conjunction with straps to force a busy condition at the local end when this is a requirement. In Model 2, the switching circuits can be conditioned by strapping to busy the local or remote end, or both ends simultaneously. Figure 7 provides a list of suggested applications of the busy switch functions. The list is for reference only. Actual requirements will depend upon local conditions.

Figure 7. Local/Remote Busy Applications

Trunk Application ①		Local Busy	Remote Busy
Without C-lead	One way, outgoing	In	Out
	One way, incoming	Out	In
	Two way ②	In	In
	Tandem ③		
With C-lead	One way, outgoing	Out	Out
	One way, incoming	Out	In
	Two way	Out	Out
	Tandem ③		
#3 EAX	One way, outgoing	Out	In
	One way, incoming	In	Out
	Two way, common control	Out	In
	Two way SXS	In	In

Notes:

① These are suggested applications. Actual requirements may vary with differing local conditions.

② This arrangement will cause seizure in both directions. If this is administratively unacceptable, strap both conditions out.

③ Busy-out is not recommended at tandem points.

Figure 8. 91402 Shelf Wiring

Lead Designation and Function	Pin Nos.	Cable Connector	
		Digroup A	Digroup B
T1/R1, Two-wire vf	37/38	J101	J105
A/B, Signaling	35/36	J102	J106
E/SG, Signaling	43/44	J103	J107
M/SB, C1 or F, Signaling	39/40	J104	J108

Figure 9. 91404 Shelf Wiring

Lead Designation and Function	Pin Nos.	Cable Connector	
		Digroup A	Digroup B
T/R, Four-wire XMT	35/36	J102	J106
T1/R1, Four-wire RCV	37/38	J101	J105
E/SG, Signaling	43/44	J103	J107
M/SB, C1 or F, Signaling	39/40	J104	J108

3.12 Model 1 Switching. Placing the switch in the BUSY position causes the TMB circuit to output a logic 1 to gate 4, enabling it. This switches gate 2, which lights the BUSY LED. Also, the output of gate 4 is inverted, and if S is strapped, the output of gate 6 goes low, causing the receive signaling circuit to energize the E relay and ground the E lead. If R is strapped, gate 6 is enabled by the busy switch, releasing the E relay.

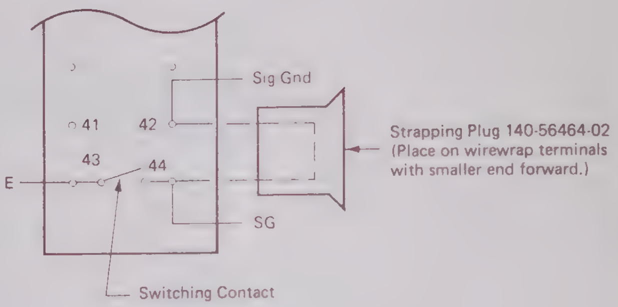
3.13 Model 2 Switching. Under normal conditions, gate 6 and the TMB circuit receive a ground input, which may be supplied from the switch via straps O and S, or independently of the switch via straps P and R. Removal of the ground input from the TMB circuit forces a local busy through a process similar to that described for the Model 1 unit. Removal of the ground input from gate 6 forces a busy at the remote end by transmission of an off-hook signal. With the right combination of strapping, the switch can be used to busy either or both ends of the system.

---

4. INSTALLATION

Figure 10. TMB Strapping on the 91400 Shelf

Figure A.



Strapping Plug 140-56464-02 (Place on wirewrap terminals with smaller end forward.)

Notes:

1. Factory Strapping. Figure A shows factory strapping on a typical channel unit receptacle connector. When the channel unit is unplugged, switching contacts 43 and 44 close ground to the E lead.

2 End Office. To ensure that the trunk circuit is made idle or busy, as applicable, when a channel unit is unplugged, the strapping plug should be left as shown in Figure A or moved to a parking position on terminals 41 and 43 according to the table below.

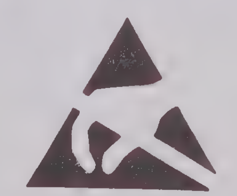
Trunk	Signaling Interface	Figure A
One-way outgoing or two-way	Type I	No change
	Type II	Strapping plug to park
	Type III	No change
One-way incoming	Type I	Strapping plug to park
	Type II	Strapping plug to park
	Type III	Strapping plug to park

3 Tandem Office. If the channel unit is strapped for the back-to-back or PLR option, the strapping plug on the receptacle connector must be moved to the parking position on terminals 41 and 43. Otherwise, a ground will be applied to resistance battery at the E relay front contact via pin 44.

4.01 The 91402 and 91404 are installed in any channel unit slot of the 91400 Terminal Equipment Shelf. Handle channel units carefully to avoid damaging components mounted on the printed circuit board. Spare units should be stored in shipping boxes or in a spare shelf.

CAUTION

A number of electronic solid state devices may be permanently damaged by static electricity encountered in their routine handling, testing, and shipping. In some circuits the possibility of damage continues after the device is installed on a printed wiring board. GTE Lenkurt is identifying printed wiring boards that are electrostatic discharge sensitive (ESDS) by coloring the board front edge red. The boards and shipping containers also are identified with the EIA symbol for ESDS devices. See below:



For information on correct handling methods, see Section 300-910-300.

Figure 11. Dial Pulse Signaling Distortion Test (Sheet 1 of 3)

Description of Test. Continuous pulses are transmitted from each terminal and the percent break is measured at the receive terminal.

Test Equipment

26600 Signaling Test Set

91442 VF Test Set or 91443 Test Patch Panel

725A Cord: low-resistance, two-conductor cable 3.6 metres (12 feet) long wired between tip and sleeve of 310-type plugs.

796A Patch Cord: twelve-conductor cable with a printed circuit plug connector on each end; -01, 1.8 metres (6 feet) long; or -02, 3.6 metres (12 feet long).

6100D-02 Cord: shielded, two-conductor cable 3.0 metres (10 feet) long with a 310-type plug on one end and a miniature tip-ring-sleeve plug on the other end; two required for Figure A or B test setup.

6100L-01 Cord: same as 6100D-02 except tip and ring are cross-connected; two required for Figure C test setup.

Step	Procedure
	NOTE: Unless otherwise specified, controls and indicators are on the 26600 Signaling Test Set.
1	Signaling Test Set
1a	Position test set so that the internal mercury relay is properly oriented.
1b	Connect −48V/GRD jack to office battery with a 725A Cord.
1c	Set all red-handled keys to center position.
1d	Set E key to O/G and M key to B/G.
1e	Set toggle switch to DIAL PULSE.
1f	Adjust SET FULL SCALE control for meter reading of 0% break.
1g	Set toggle switch to CONT PULSE.
1h	Set ADJ % BREAK controls as follows: COARSE to center position and FINE full clockwise.
1i	While depressing PRESS TO MEASURE SPEED pushbutton, adjust FINE control for a steady meter reading, and then adjust ADJ SPEED control for a reading of 12 pulses per second. Release pushbutton
1j	Adjust COARSE and FINE controls for meter reading of 60.5% break.
1k	Because controls are interacting, repeat steps 1i and 1j.
2	Test Setup
2a	Select Figure A, B, or C, as applicable. NOTE: If the signaling test set is 26600-M2, the back-to-back option can be tested using Figure A instead of Figure C.
2b	Connect CHANNEL UNIT receptacle connector on 91442 or 91443 to TEST receptacle connector on channel unit with 796A Patch Cord.
	NOTE: The 91442 VF Test Set and the 91443 Test Patch Panel have two sections, left and right. Either section may be used.
2c	Connect LINE and DROP jacks on signaling test set to E&M CARR and DROP jacks on 91442 or 91443 as shown in Figure A, B, or C.
3	Trunk Conditioning
3a	Set channel unit NORM/BUSY switch to BUSY.
3b	E&M option (Figure A): set TWD DROP key to ON HOOK if LINE lamp is lighted or OFF HOOK if LINE lamp is dark.
3c	Back-to-back or PLR option (Figure B or C): set TWD LINE key to ON HOOK if DROP lamp is lighted or OFF HOOK if DROP lamp is dark.
3d	Set channel unit NORM/BUSY switch to NORM.
4	Sending Pulses to the Carrier
4a	E&M option (Figure A): set controls on the signaling test set as follows: M key to B/G (type I or III) or B/O (type II) TWD LINE key to OFF HOOK PULSE key to LINE NOTE: If the channel unit is arranged for the back-to-back option and the signaling test set is 26600-M2 (as noted in Step 2), set the M key to G/O.
4b	Back-to-back or PLR option (Figure B or C): set controls on the signaling test set as follows: E key to O/G TWD DROP key to OFF HOOK PULSE key to DROP
4c	Test set is now pulsing the carrier at 12 pps and 60.5% break.
4d	Pulses measured at the distant terminal should be according to the type of channel unit there. Refer to Step 5 below or to the applicable GTEP Section.
5	Measuring Pulses from the Carrier
5a	Have the distant terminal send a steady off-hook. NOTE: The E key and M key positions do not affect pulse measurement.
5b	E&M option (Figure A): set MEASURE key to LINE. NOTE: If the E&M signaling interface is type II, the SG (ground) lead from the trunk circuit is wired to pin 44 of the channel unit. If this wiring is not in place, pin 44 can be grounded temporarily by installing a strapping plug between pins 42 and 44 as described in figure 10.
5c	Back-to-back or PLR option (Figure B or C): set MEASURE key to DROP.
5d	Adjust SET FULL SCALE control for meter reading of 0% break.

Figure 11. Dial Pulse Signaling Distortion Test (Sheet 2 of 3)

Step	Procedure	Step	Procedure
5e	Have the distant terminal send continuous pulses at 12 pps and 60.5% break.	6	Completion of Test
5f	Meter should read according to distant channel unit type as follows: E&M channel unit: 58.5% to 62.5% break DPO channel unit: 52% to 72% break	6a	Restore channel to operation
		6b	To test another channel, return to step 2.

Installer Wiring

4.02 The 91400 Terminal Equipment Shelf provides mounting positions for 48 channel units, which are arranged in digroups A and B and numbered 1A through 24A and 1B through 24B. Figure 8 provides information on shelf wiring and associated cable connectors for the 91402. Figure 9 provides this information for the 91404 unit. To complete the installation, utilize cable assembly 163-10315-xx or 163-10316-xx, or equivalent. Refer to Section 342-911-111 for details.

Strapping

4.03 Channel Unit. Strap the channel unit for the applicable options as tabulated in figure 6.

4.04 Shelf. Refer to figure 10 to properly condition the trunk when the channel unit is removed from the shelf. This figure shows possible changes to factory-strapping on the channel unit receptacle connectors.

5. MAINTENANCE

5.01 Detailed system testing and troubleshooting are covered in Section 342-911-112. Figure 11 in this Section is a procedure for measuring dial pulse signaling distortion over the carrier system on an end-to-end basis.

Figure 11. Dial Pulse Signaling Distortion Test (Sheet 3 of 3)

Figure A. Test Setup for Standard E&M Signaling Option

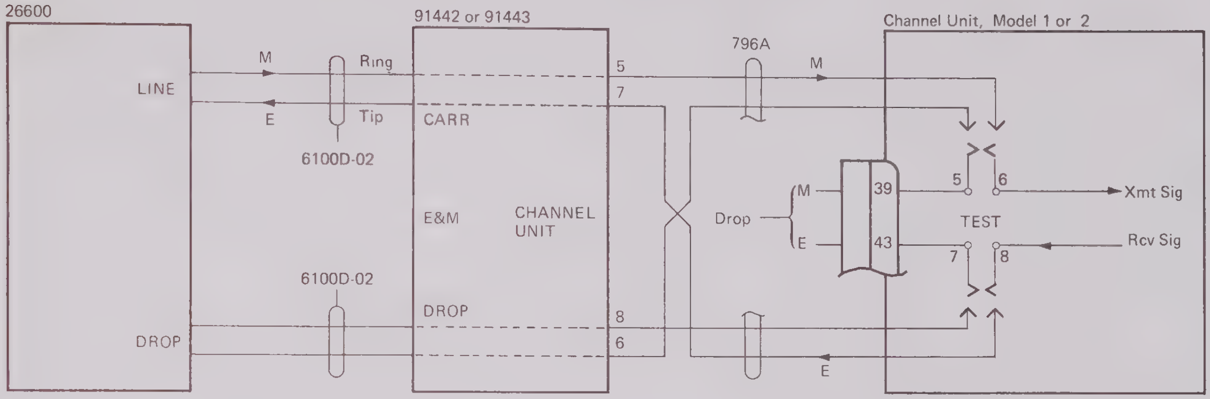

26600
LINE
DROP
M
E
Ring
Tip
6100D-02
6100D-02
91442 or 91443
CARR
E&M
CHANNEL UNIT
DROP
5
7
8
6
796A
M
E
Drop
M
E
39
43
Channel Unit, Model 1 or 2
5
6
7
8
TEST
Xmt Sig
Rcv Sig

Figure B. Test Setup for PLR Signaling Option

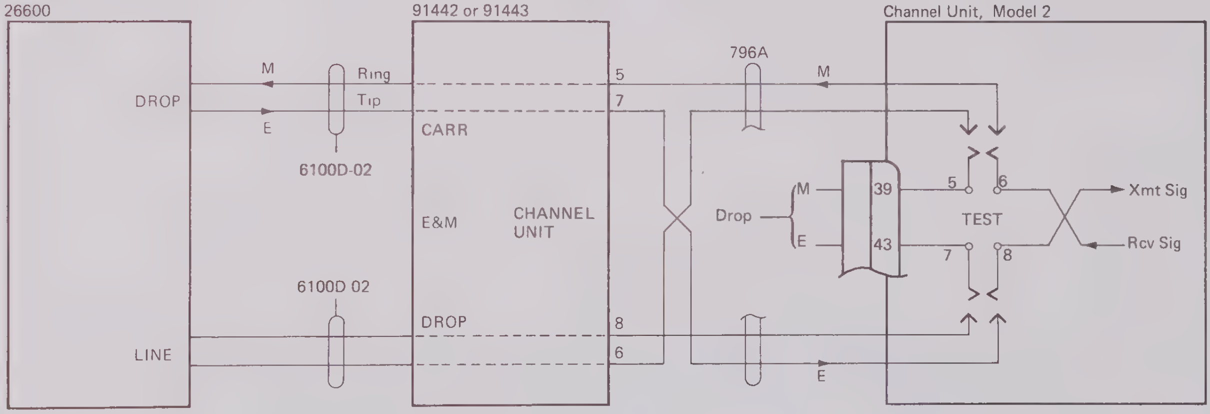
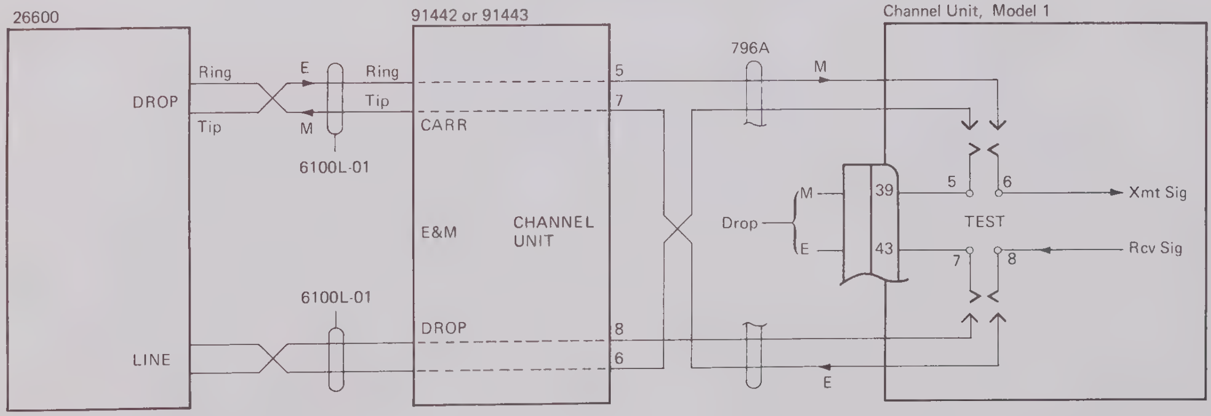

26600
DROP
LINE
M
E
Ring
Tip
6100D-02
6100D 02
91442 or 91443
CARR
E&M
CHANNEL UNIT
DROP
5
7
8
6
796A
M
E
Drop
M
E
39
43
Channel Unit, Model 2
5
6
7
8
TEST
Xmt Sig
Rcv Sig

Figure C. Test Setup for Back-to-Back Signaling Option


26600
DROP
LINE
Ring
Tip
E
M
Ring
Tip
6100L-01
6100L-01
91442 or 91443
CARR
E&M
CHANNEL UNIT
DROP
5
7
8
6
796A
M
E
Drop
M
E
39
43
Channel Unit, Model 1
5
6
7
8
TEST
Xmt Sig
Rcv Sig

342—911—114

GTE LENKURT

Company Headquarters and Manufacturing Facility
1105 County Road
San Carlos, California 94070
Phone 415–595-3000

Albuquerque Manufacturing Facility
One Camino de Lenkurt
Albuquerque, New Mexico 87123
Phone 505–296-0551

El Paso Manufacturing Facility
10727 Gateway West
El Paso, Texas 79935
Phone 915 -593 3400

District Sales Offices
1105 County Road
San Carlos, California 94070
Phone 415– 595-3000

120 West Eastman Street
Arlington Heights, Illinois 60004
Phone 312–398-6700

542 Haggard Street, Suite 510
Plano, Texas 75074
Phone 214–422-4305

3015 Williams Drive
Fairfax, Virginia 22031
Phone 703–698-1850

5780 Peachtree-Dunwoody Road, N.E.
Suite 145
Atlanta, Georgia 30342
Phone 404–256-3000

GTE International Sales Office
1105 County Road
San Carlos, California 94070
Phone 415–595-3000
Cable: GENTELINT

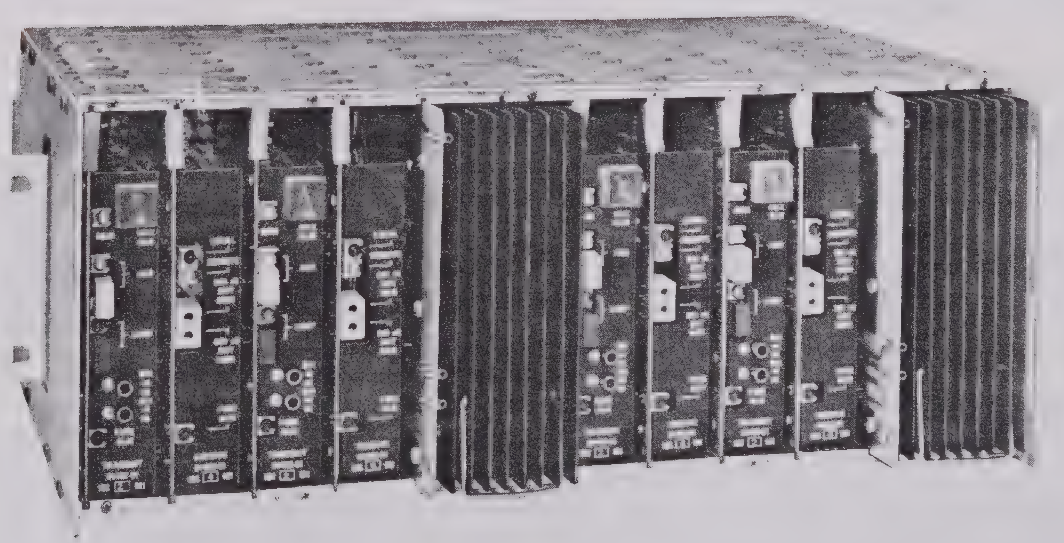
9122A Asynchronous Digital Multiplexer

APPLICATIONS

- Combines two asynchronous 1.544 Mb/s DS1 signals into a 3.152 Mb/s DS1C format. End-to-end compatible with Western Electric Company's M1C multiplexer.
- Operates over T1C-type lines, or T1-type lines retrofitted with GTE Lenkurt's 9148A Modified Duobinary repeaters.

FEATURES

- Easy to engineer and install.
- Four muldems and two power supplies (one redundant) occupy only four rack mounting spaces (178 mm or 7 inches).
- Only one circuit card for each direction of transmission reduces spares held in stock.
- Rapid service restoration through simple card changeout—no hot standby needed.
- Fully compatible with DSX-1 and DSX-1C Cross-Connect Plan.
- Local channel banks operating with the 9122A need not be co-located—may be up to 402 m (1320 feet) away.
- Equalization part of cabling—changeout of cards does not require change of equalization.
- Fully alarmed for local and remote outages.
- Optional alarm panel—one mounting space high—serves entire rack of muldems.



TECHNICAL SUMMARY

Signal Inputs and Outputs:	
Low-speed (1.544 Mb/s)	Two 24-channel DS1 signals
High-speed (3.152 Mb/s)	One 48-channel DS1C signal
DS1 Interface:	
Line rate	1.544 Mb/s ±130 ppm
Line Code	Bipolar
Pulse Amplitude, base-to-peak:	
Multiplexer input (transmit unit)	1.5 to 3.3 volts
Multiplexer output (receive unit)	6.0 ± 0.6 volts into shelf-mounted, 6-dB pad or cable equalizer
Pulse characteristics at DSX-1:	
Amplitude, base-to-peak	3.0 volts ±10%
Width at 50% amplitude	324 ±30 nanoseconds
Rise and decay time	Less than 80 nanoseconds between 10% and 90% amplitude
Power ratio, positive to negative pulses	Less than 0.5 dB
Line impedance	110 ohms ±5% balanced
Signal statistics	Average pulse density at least 1 in 8; not more than 15 consecutive 0's
Maximum DS1 signal cable length, multiplexer to DSX-1 cross-connect:	
GTS 8507 cable	166 m (544 feet)
GTS 8510 or ABAM cable	200 m (655 feet)
DS1C Interface:	
Line rate	3.152 Mb/s ±30 ppm
Line code	Bipolar
Pulse amplitude, base-to-peak:	
Multiplexer output (transmit unit)	3.95 volts ±10% into shelf-mounted 2-dB pad or cable equalizer
Multiplexer input (receive unit)	1.7 to 3.3 volts
Pulse characteristics at DSX-1C:	
Amplitude, base-to-peak	3.0 volts ±10%
Width at 50% amplitude	160 ±20 nanoseconds
Power ratio, positive to negative pulses	Less than 0.5 dB
Line impedance	110 ohms ±5% balanced
Signal statistics	Average pulse density at least 1 in 8 over 130 consecutive time slots
Maximum DS1C signal cable length, multiplexer to DSX-1C cross-connect:	
GTS 8507 cable	105 m (344 feet)
GTS 8510 or ABAM cable	122 m (400 feet)
Alarm Signals, Local and Remote:	
Non-alarm	Logic 0 (not over 0.5 volt)
Alarm	Logic 1 (at least 2.7 volts)
Controls:	
ACO switch	Silences audible alarm. Extinguishes MEM lamp. Enables (does not activate) loop circuit under alarm conditions.
LOOP switch	Push-push switch. Activates loop circuit when circuit has first been enabled by ACO switch.
Indicators:	
LOCAL lamp (local alarm)	Red LED. Indicates failure detected at near end of system. Lights when out-of-frame condition lasts beyond 200 milliseconds.
REM lamp (remote alarm)	Yellow LED. Indicates failure detected at far end of system.
MUX ALM lamp (time-delay alarm)	Amber incandescent. Lights when local alarm, remote alarm, or fuse alarm lasts 1.0 ±0.5 seconds.
ACO lamp (alarm cutoff)	Red LED, white lens. Lights when ACO circuits are activated.
MEM lamp (alarm memory)	Yellow LED. Lights when MUX alarm occurs. Extinguishes when ACO switch is operated.
LOOP lamp	Green LED. Indicates multiplexer is looped.
FUSE ALM lamps	Red LED. Indicates blown fuse in +8, —15, or —48 volt circuits.
Test Points:	
DS1 #1 and #2 IN	Miniature telephone jacks for test signal insertion. Contain switching contacts which disable all-ones receiver output when multiplexer is looped.
DS1 #1 and #2 OUTPUT MON	Allows bridging of DS1 outputs for monitoring purposes.
Voltage T.P. (on power supply)	For measurement of +8, —15, and —48 volts.
Power Requirements:	
Source voltage	—48 Vdc (44 to 56 Vdc)
Current (fully-equipped shelf)	2.1A maximum

TECHNICAL SUMMARY (Continued)

Environment:

Ambient Temperature:	
Operate	0°C to 50°C (32°F to 122°F)
Storage	—40°C to +65°C (—40°F to 149°F)
Maximum relative humidity	95% at 40°C
Maximum operating altitude	4.57 km (15,000 feet)

	Dimensions (H, W, D)		Weights	
Weights and Dimensions	Millimeters	Inches	kg	lbs
91481 Muldem Shelf	178 x 475 x 356	7.0 x 18.7 x 14.0	4.5	10.0
91482 Transmit Unit	48 x 36 x 292	6.5 x 1.4 x 11.5	0.4	0.9
91483 Receive Unit	48 x 36 x 292	6.5 x 1.4 x 11.5	0.4	0.9
91484 Power Supply Unit	48 x 66 x 310	6.5 x 2.6 x 12.2	2.0	4.5
91485 Alarm Panel	44 x 475 x 216	1.7 x 18.7 x 8.5	0.5	1.2
91155 Fuse and Alarm Panel	89 x 475 x 254	3.5 x 18.7 x 10.0	3.6	8.0

GTE Lenkurt reserves the right to change performance specifications where necessary to meet industry requirements.

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1. GENERAL

1.01 This Section describes the GTE Lenkurt 9122A Asynchronous Digital Multiplexer and its function as an interface between the DS1 (1.544 Mb/s) and DS1C (3.152 Mb/s) digital transmission systems. Included are specifications, functional operation, engineering considerations, ordering information, installation, and maintenance. Publications on associated equipment are listed in figure 1-1.

Figure 1-1. Associated Publications

GTE Practices Section	Title
342-910-120	9102A 48-Channel Repeatered Line
342-910-104	9148A Modified Duobinary Repeater Line Equipment
342-521-100	5215B Miniature Jackfield Assembly
788-160-070	Aluminum Channel Racks and Accessories
788-161-070	31000 Series Unequal Flange Duct Equipment Racks and Accessories
836-910-074	9148A Modified Duobinary Line Retrofit Engineering Considerations
836-910-080	Digital Signal Cross Connections
032-201-150	GTE Lenkurt Test Cord, Plug, and Adapter Assemblies
342-910-105	9104A 24/48 Channel Repeatered Line Inside Plant Equipment
342-910-106	9104A 24/48 Channel Repeatered Line Outside Plant Equipment

1.02 This issue of Section 342-911-122 makes the following changes.

(a) Adds/changes circuits in 91481, 91482, 91483, 91484, 91485, and 91155 diagrams.

(b) Replaces cross-connect and patching, figure 3-8.

(c) Adds 3 new standard rack assemblies.

(d) Replaces power distribution, figure 6-2.

Significant changes are indicated by marginal arrows.

1.03 The equipment covered in this publication is the latest model as of the publication date. Later models are capable of greater application or are more effective in performance of their functions than earlier models. A later model supersedes an earlier model of the same type number and may always be substituted for the earlier model.

2. DESCRIPTION

2.01 The 9122A Asynchronous Digital Multiplexer combines two DS1 (T1) digital signals into a single DS1C (T1C) digital signal and, conversely, separates a DS1C signal into two DS1 signals. DS1 means "digital signal at the first level" and refers to the low speed (1.544 Mb/s) bipolar pcm line signal. DS1C designates the high speed (3.152 Mb/s) bipolar pcm line signal.

2.02 Some applications are illustrated by block diagram in figure 2-1. The 9122A is end-to-end compatible with the WECo M1C multiplexer and may be used in conjunction with the GTE Lenkurt 9102A 48-Channel Repeatered Line Equipment (T1C type) or 9148A Modified Duobinary Repeatered Line Equipment.

2.03 A muldem (multiplexer/demultiplexer) consists of one 91482 Transmit Unit (multiplexer) and one 91483 Receive Unit (demultiplexer). This combination, equipped with a 91484 Power Supply Unit on a 91481 shelf, will multiplex two 24-channel DS1 signals into a single 48-channel DS1C signal and perform the reverse demultiplexing function. The shelf can be equipped with up to four muldems and two power supply units (one a backup unit). The shelf is designed for a 483-mm (19-inch) rack; the units are modular plug-ins. Dimensions and weights are given in the Technical Summary.

3. FUNCTIONAL OPERATION

Signal Format

3.01 Format of the DS1C pattern is illustrated in figure 3-1. The DS1 data streams (1 and 2) are combined by interleaving the time slots, followed by scrambling in a single-stage scrambler circuit. Into the interleaved pattern, a group of 24 control bits is repetitively inserted in such a way that each control bit is followed by 52 scrambled data bits (26 DS1 No. 1 bits and 26 DS1 No. 2 bits). This format is defined by the AT&T M1C Multiplex Technical Reference and Compatibility Specification No. L171907.

Transmit Functions

3.02 Figure 3-2 is a block diagram of the 91482 Transmit Unit.

3.03 The transmit portion of the 9122A Multiplexer Assembly receives two asynchronous, 1.544 Mb/s data streams and combines them into a single 3.152 Mb/s

Figure 2-1. Applications of the 9122A Multiplexer

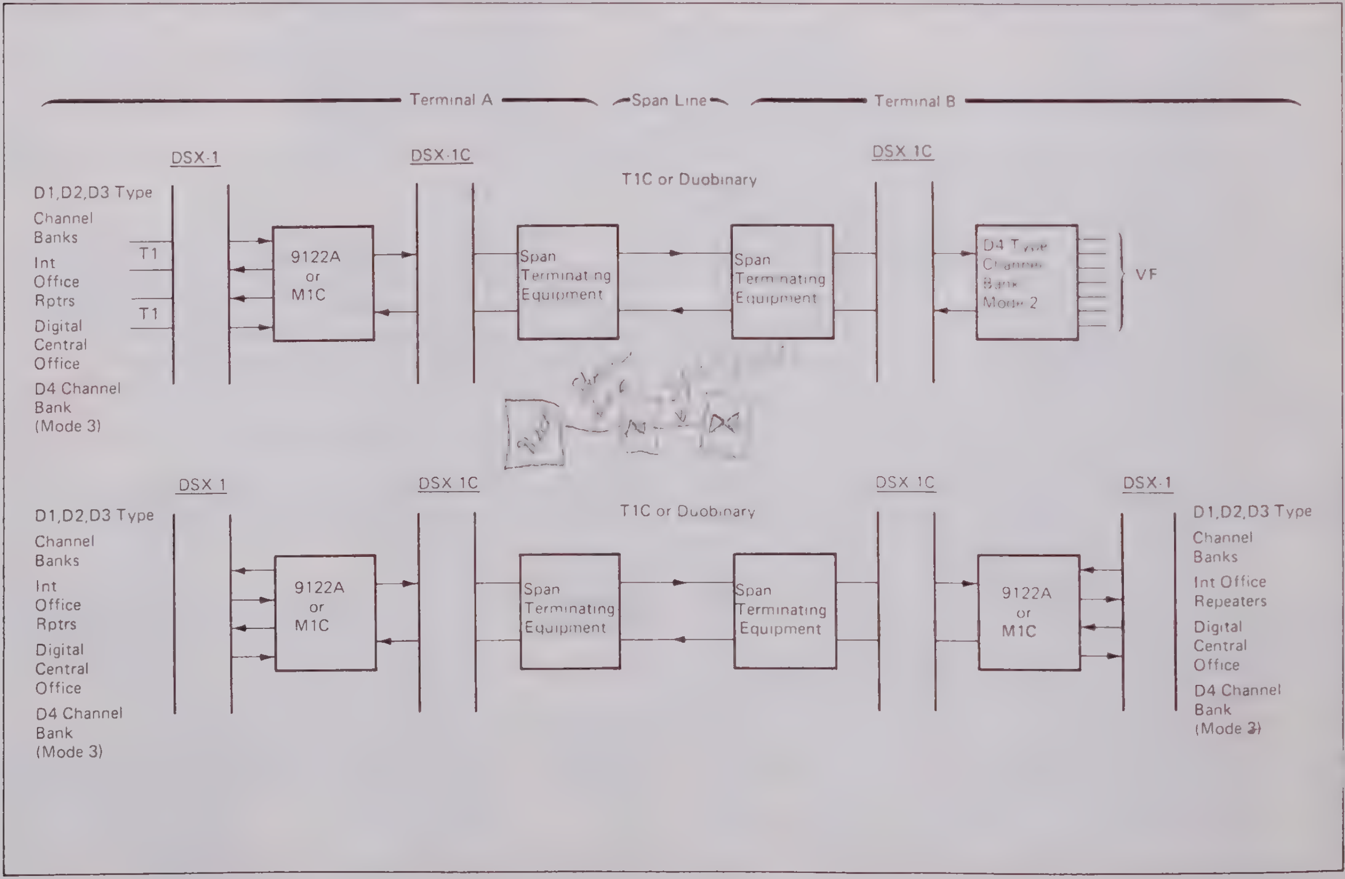

Terminal A
Span Line
Terminal B
DSX-1
DSX-1C
DSX 1C
T1C or Duobinary
D1,D2,D3 Type
Channel
Banks
Int
Office
Rptrs
Digital
Central
Office
D4 Channel
Bank
(Mode 3)
T1
T1
9122A
or
M1C
Span
Terminating
Equipment
Span
Terminating
Equipment
D4 Type
Channel
Bank
Mode 2
VF
DSX 1
DSX 1C
T1C or Duobinary
DSX 1C
DSX-1
D1,D2,D3 Type
Channel
Banks
Int
Office
Rptrs
Digital
Central
Office
D4 Channel
Bank
(Mode 3)
9122A
or
M1C
Span
Terminating
Equipment
Span
Terminating
Equipment
9122A
or
M1C
D1,D2,D3 Type
Channel
Banks
Int Office
Repeaters
Digital
Central
Office
D4 Channel
Bank
(Mode 3)

Figure 2-2. Front and Rear Views of 9122A Asynchronous Digital Multiplexer

Figure A. Front View

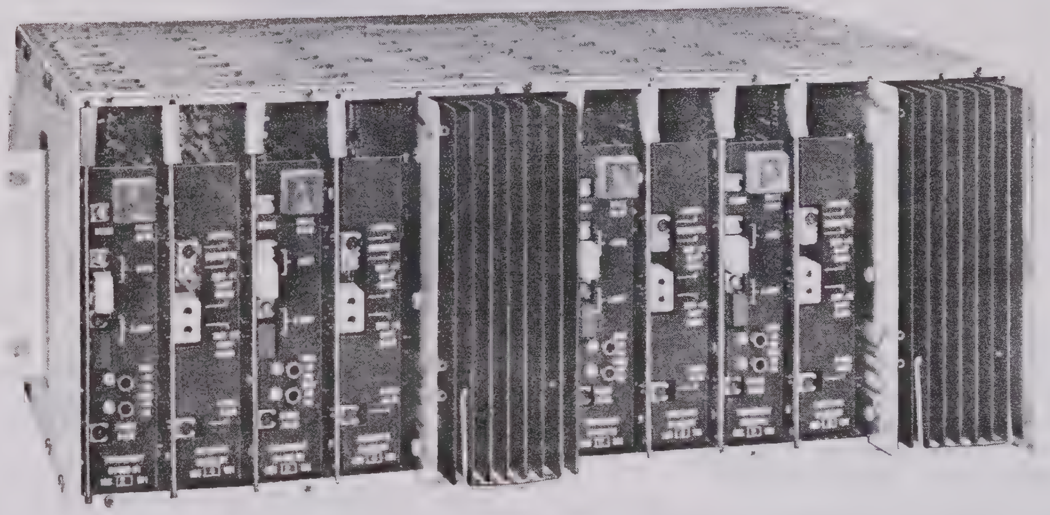


Figure B. Rear View With Back Cover Removed, 91485 Alarm Panel Mounted

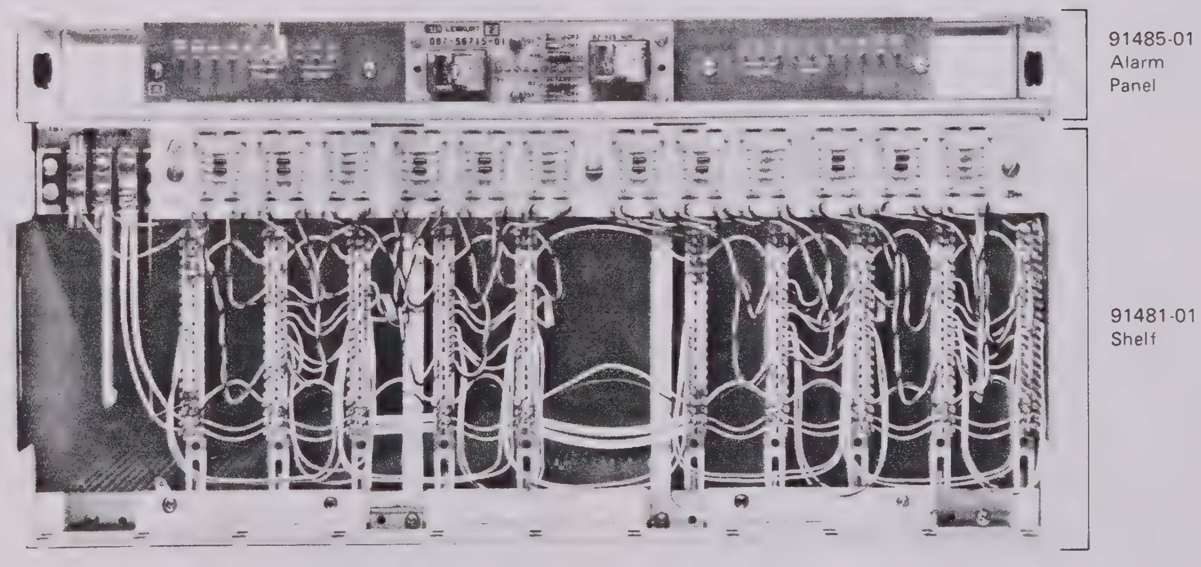
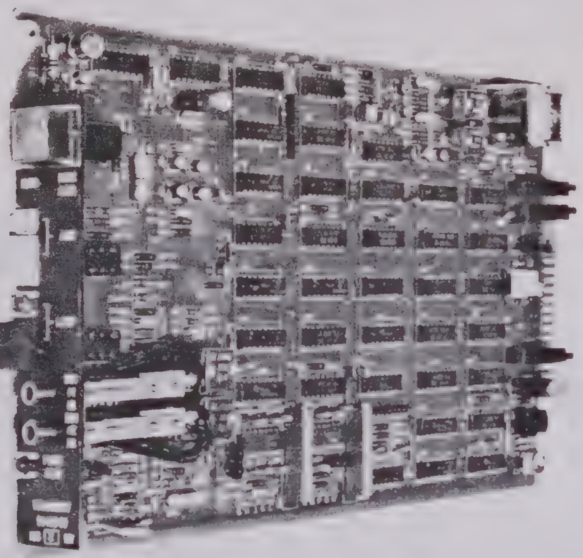

91485-01
Alarm
Panel
91481-01
Shelf

Figure 2-3. Typical Plug-in Unit (91482 Transmit Unit)



data stream for M1C applications. The process involves bipolar to unipolar conversion, clock recovery, synchronization of the incoming signals, scrambling, control bit insertion, and unipolar to bipolar conversion.

3.04 Bipolar Conversion and Clock Recovery. The incoming DS1 signals are first converted from bipolar to unipolar format, and a clock (timing pulses) is extracted from each signal. The clock pulses and the information bits are separately fed to an elastic store circuit. Clock recovery is by means of a phase-locked loop, and there is always a clock output, even with loss of the signal input.

3.05 Elastic Store. The elastic store is an eight-bit shift register for accepting the incoming bit stream. Each bit stream is "written" into an elastic store circuit by means of the write clock (recovered from the bit stream) at the incoming DS1 rate of 1.544 Mb/s. The bit streams are processed out of the elastic store in synchronism with a read clock common to both streams. The DS1 No. 2 signal is inverted in the process; that is, a 1 applied to the DS1 No. 1 input is transmitted as a 1, while a 1 applied to the DS1 No. 2 input is transmitted as a 0.

3.06 Stuff-Enable Circuit. This circuit processes the read clock required by the elastic store. The clock is generated at a frequency of 1.576 MHz, or 32 kHz higher than the information bit rate. The circuit removes pulses from the read clock until the number of bits is equal to those in the write clock and information bit streams.

3.07 As the write clock and the read clock drift apart in phase by one cycle from reference, a stuff request is initiated by the elastic store. The stuff-enable circuit stops the read clock for one cycle, allowing the preceding information bit to be read again (stuffed). In this manner, frequency difference between the clocks is corrected. Signal format (figure 3-1) limits stuffing to designated time slots in the first and third subframes for DS1 No. 1 and the second and fourth subframes for DS1 No. 2. Other extra time slots are provided for the insertion of control and framing bits.

3.08 Loss of Data. The loss-of-data circuit is a re-triggerable one-shot multivibrator which will time-out after 100 microseconds without a pulse at the DS1 input. When loss of data is detected, the output of the elastic store is forced to a 1 state for DS1 No. 1 and to a 0 state for DS1 No. 2.

3.09 Data Combiner. In this circuit, the two DS1 bit streams are interleaved to form a single high-speed bit stream.

3.10 Scrambler. The scrambler circuit prevents the buildup of a long, unbroken series of 1's or 0's which otherwise would appear as power spectrum concentrations during the idle periods and cause disturbances to adjacent transmission lines. It also prevents long sequences of 0's to aid in clock recovery.

3.11 Control Bits and Bipolar Conversion. The high-speed bit stream from the scrambler and the C, F, and M control bits are applied to a combiner circuit where integration of the control bits into the bit stream takes place. The ensuing DS1C stream is converted from unipolar to bipolar form. Basic timing for application of the DS1C signal to a repeatered line is provided by the 3.152 Mb/s master clock.

3.12 DS1C All-1's Generator. The DS1C all-1's generator places an all—1's, bipolar-format signal on the high-speed span line when the DS1C output of the transmit unit is looped.

3.13 DS1 All-1's Generator. The DS1 all-1's generator puts out an all-1's bipolar signal for transmission over the DS1 repeatered lines when the multiplexer is looped.

3.14 DS1 All-1's Circuit. With activation of the loop circuit, an all-1's circuit is also activated. The receiver is forced to all-1's DS1 output to provide a repeatered line input and force the channel banks into alarm to prevent trunk seizure. Access to the loop circuit for test signal insertion is through jacks DS1 No. 1 IN and DS1 No. 2 IN on the transmit unit. The insertion of a test signal into the jacks operates switches which deactivate the all-1's circuit, enabling the test signal to be monitored at jacks on the receive unit.

Receive Functions

3.15 Figure 3-3 is a block diagram of the 91483 Receive Unit.

3.16 Main Signal Flow. The DS1C signal passes through the looping relay in the transmit unit, to the input of the 91483 Receive Unit, and then through a 15-dB isolation pad to a circuit which converts the signal from

Figure 3-1. 9122A and WECo M1C Frame Format

FIGURE A. CONTROL BIT SEQUENCE.

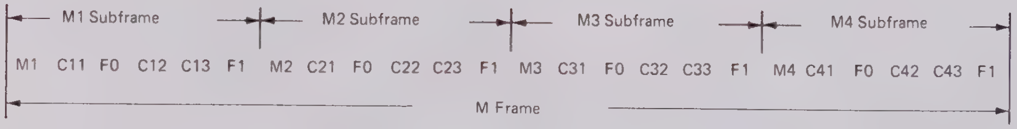
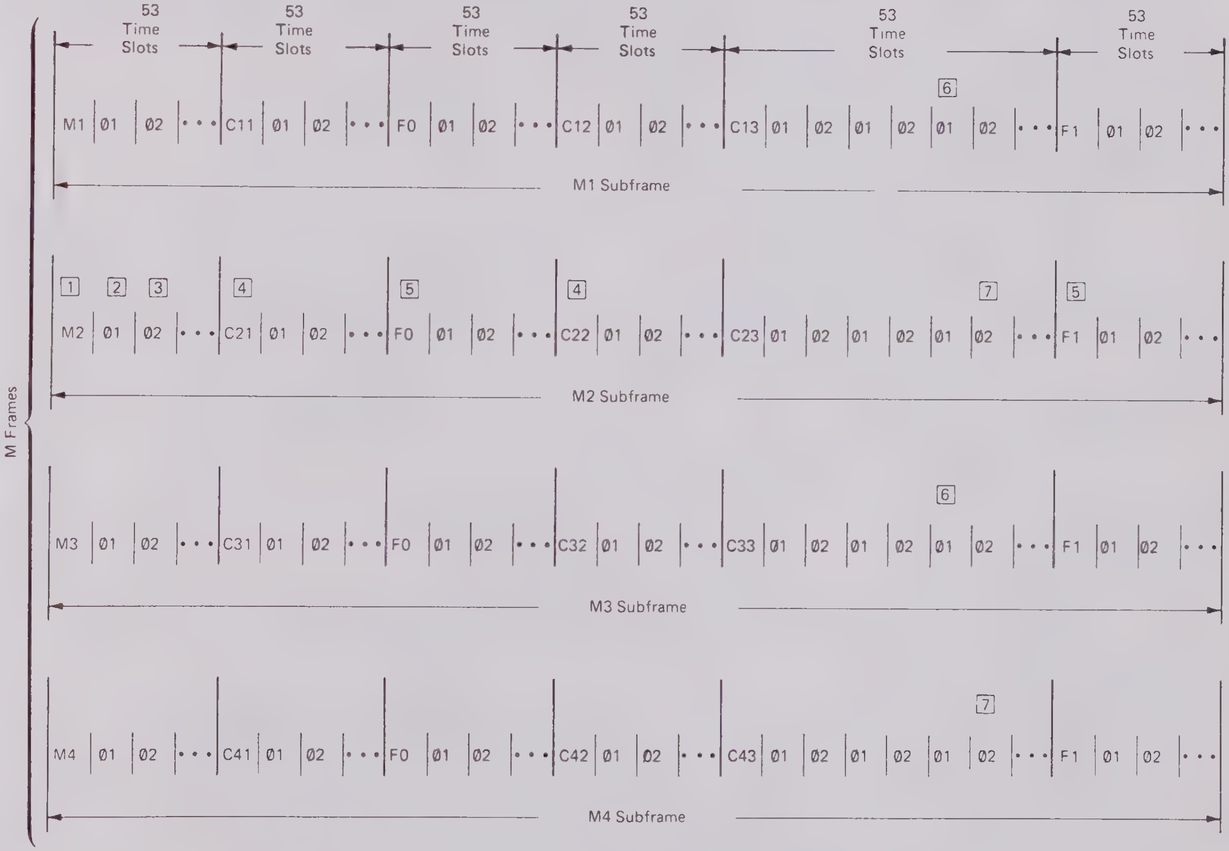

M1 Subframe
M2 Subframe
M3 Subframe
M4 Subframe
M1 C11 F0 C12 C13 F1 M2 C21 F0 C22 C23 F1 M3 C31 F0 C32 C33 F1 M4 C41 F0 C42 C43 F1
M Frame

FIGURE B. FORMAT OF DS1C DATA STREAM.


53 Time Slots
M Frames
M1 01 02 • • • C11 01 02 • • • F0 01 02 • • • C12 01 02 • • • C13 01 02 01 02 01 02 • • • F1 01 02 • • •
M1 Subframe
1 2 3 4 5 4 6 7 5
M2 01 02 • • • C21 01 02 • • • F0 01 02 • • • C22 01 02 • • • C23 01 02 01 02 01 02 • • • F1 01 02 • • •
M2 Subframe
M3 01 02 • • • C31 01 02 • • • F0 01 02 • • • C32 01 02 • • • C33 01 02 01 02 01 02 • • • F1 01 02 • • •
M3 Subframe
M4 01 02 • • • C41 01 02 • • • F0 01 02 • • • C42 01 02 • • • C43 01 02 01 02 01 02 • • • F1 01 02 • • •
M4 Subframe

NOTES

1. M1, M2, M3, M4 = Multiframe Alignment Signals.
2. 01 = DS1 No. 1 Input Time Slot before scrambling.
3. 02 = DS1 No. 2 Input Time Slot before scrambling.
4. C Bits = Stuffing Indicator Signals.
5. Fo and F1 Signals = Frame Alignment Signals.
6. Stuffing slot for DS1 No. 1 input is third DS1 No. 1 information slot following third C slot in first and third subframes.
7. Stuffing slot for DS1 No. 2 input is third DS1 No. 2 information slot following third C slot in second and fourth subframe.

Figure 3-2. Block Diagram of 91482 Transmit Unit (Sheet 1 of 2)

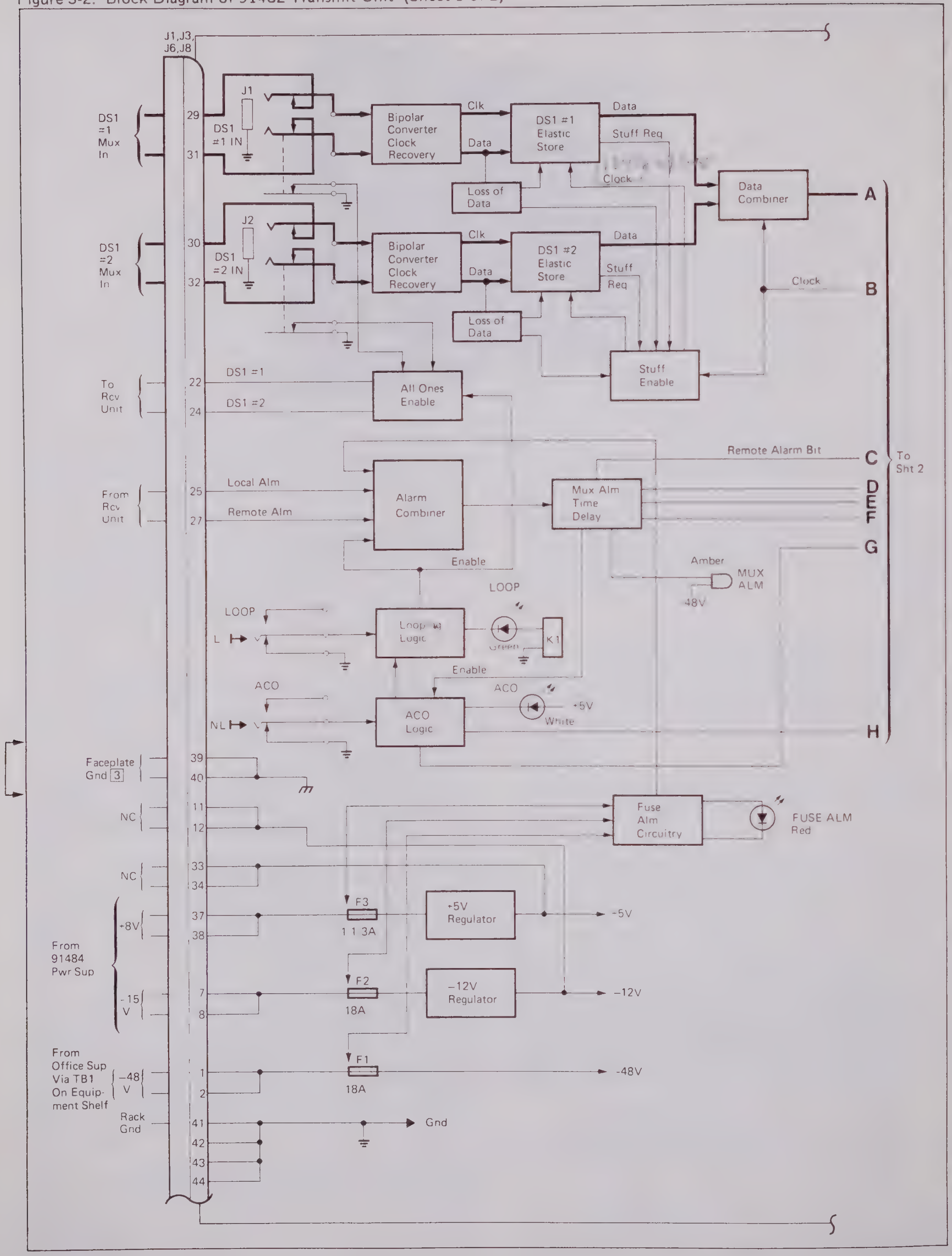
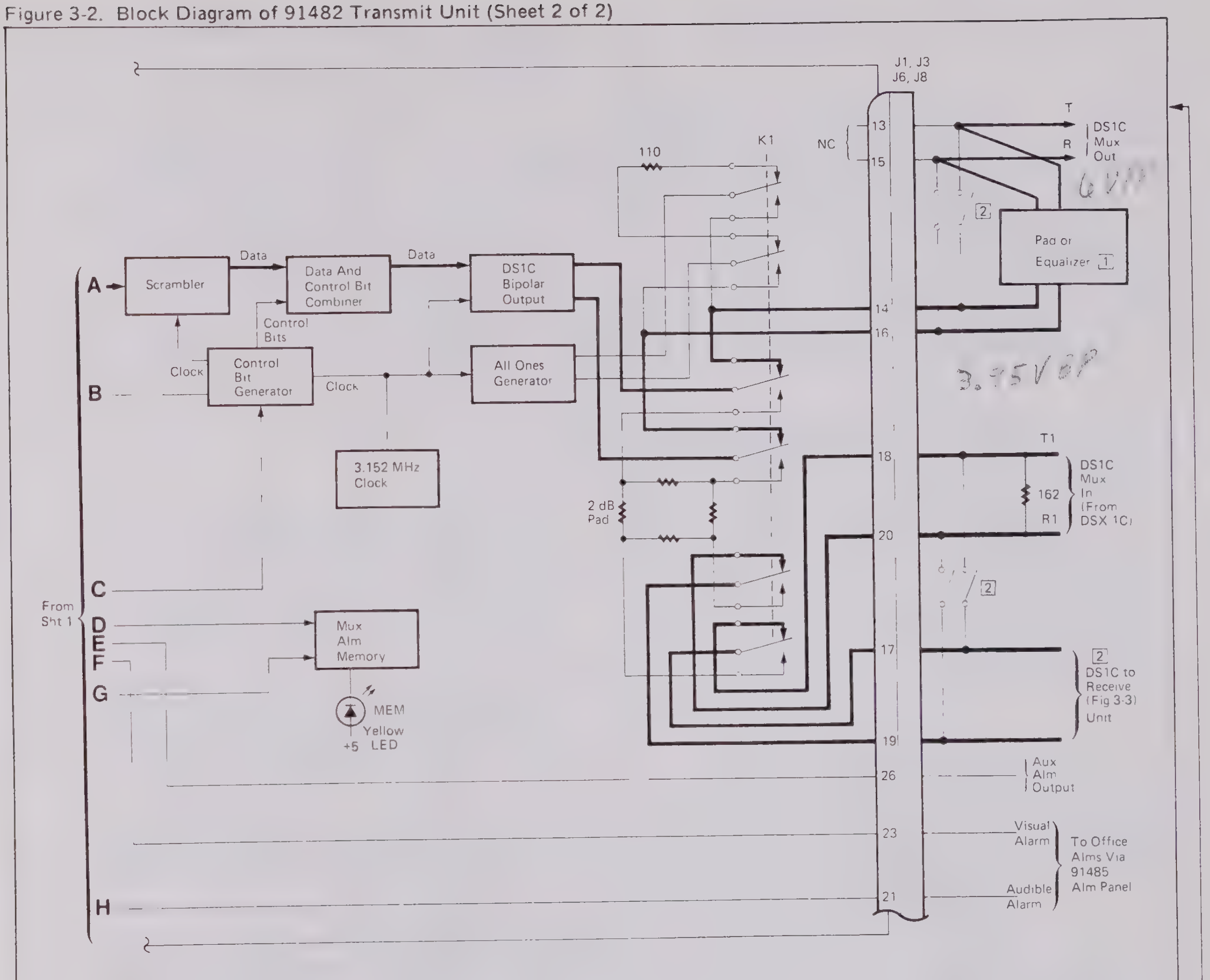

J1,J3,
J6,J8
DS1
#1
Mux
In
29
31
J1
DS1
#1 IN
Bipolar
Converter
Clock
Recovery
Clk
Data
DS1 #1
Elastic
Store
Data
Stuff Req
Clock
Loss of
Data
Data
Combiner
A
DS1
#2
Mux
In
30
32
J2
DS1
#2 IN
Bipolar
Converter
Clock
Recovery
Clk
Data
DS1 #2
Elastic
Store
Data
Stuff
Req
Loss of
Data
Clock
B
Stuff
Enable
To
Rcv
Unit
22
24
DS1 #1
DS1 #2
All Ones
Enable
Remote Alarm Bit
C
To
Sht 2
From
Rcv
Unit
25
27
Local Alm
Remote Alm
Alarm
Combiner
Mux Alm
Time
Delay
D
E
F
G
Enable
Amber
MUX
ALM
48V
LOOP
LOOP
L
Looping
Logic
Green
K1
Enable
ACO
ACO
NL
ACO
Logic
+5V
White
H
Faceplate
Gnd 3
39
40
NC
11
12
Fuse
Alm
Circuitry
FUSE ALM
Red
NC
33
34
From
91484
Pwr Sup
+8V
37
38
F3
1 1 3A
+5V
Regulator
+5V
-15
V
7
8
F2
18A
−12V
Regulator
−12V
From
Office Sup
Via TB1
On Equip-
ment Shelf
−48
V
1
2
F1
18A
-48V
Rack
Gnd
41
42
43
44
Gnd

Figure 3-2. Block Diagram of 91482 Transmit Unit (Sheet 2 of 2)


J1, J3
J6, J8
T
R
DS1C
Mux
Out
6 VP
110
K1
NC
13
15
2
Pad or
Equalizer 1
Data
Data
A
Scrambler
Data And
Control Bit
Combiner
DS1C
Bipolar
Output
Control
Bits
14
16
Clock
Control
Bit
Generator
Clock
All Ones
Generator
3.75 V bP
B
3.152 MHz
Clock
T1
18
2 dB
Pad
162
R1
DS1C
Mux
In
(From
DSX 1C)
20
C
From
Sht 1
D
E
F
G
Mux
Alm
Memory
MEM
Yellow
+5 LED
17
2
DS1C to
Receive
(Fig 3-3)
Unit
19
26
Aux
Alm
Output
23
Visual
Alarm
To Office
Alms Via
91485
Alm Panel
H
21
Audible
Alarm

NOTES

1 The outgoing DS1C at pins 14 and 16 goes through a pad or equalizer on TB2 of the shelf and returns to pins 13 and 15 where the multiplexer output connections are made at installation (refer to paragraph 6.14 and figure 7 1B)

2 If a transmit unit is not plugged into the shelf (as in one-way transmission), the following J1, J3, J6, and J8 connector switching contact pins are shorted

(a) Pins 17 to 18 and 19 to 20. The incoming DSIC signal goes to the receive unit via pins 18 20, relay K1, and pins 17 19 of the transmit unit. If the transmit unit is not plugged in, the switching contacts route the DS1C signal directly to the receive unit.

(b) Pins 13 to 14 and 15 to 16. These switching contacts have no system function and are illustrated for information only

3 Effective with issue 5 unit

bipolar to unipolar form. A 3.152-MHz clock is recovered and applied to the timing circuits in the unit.

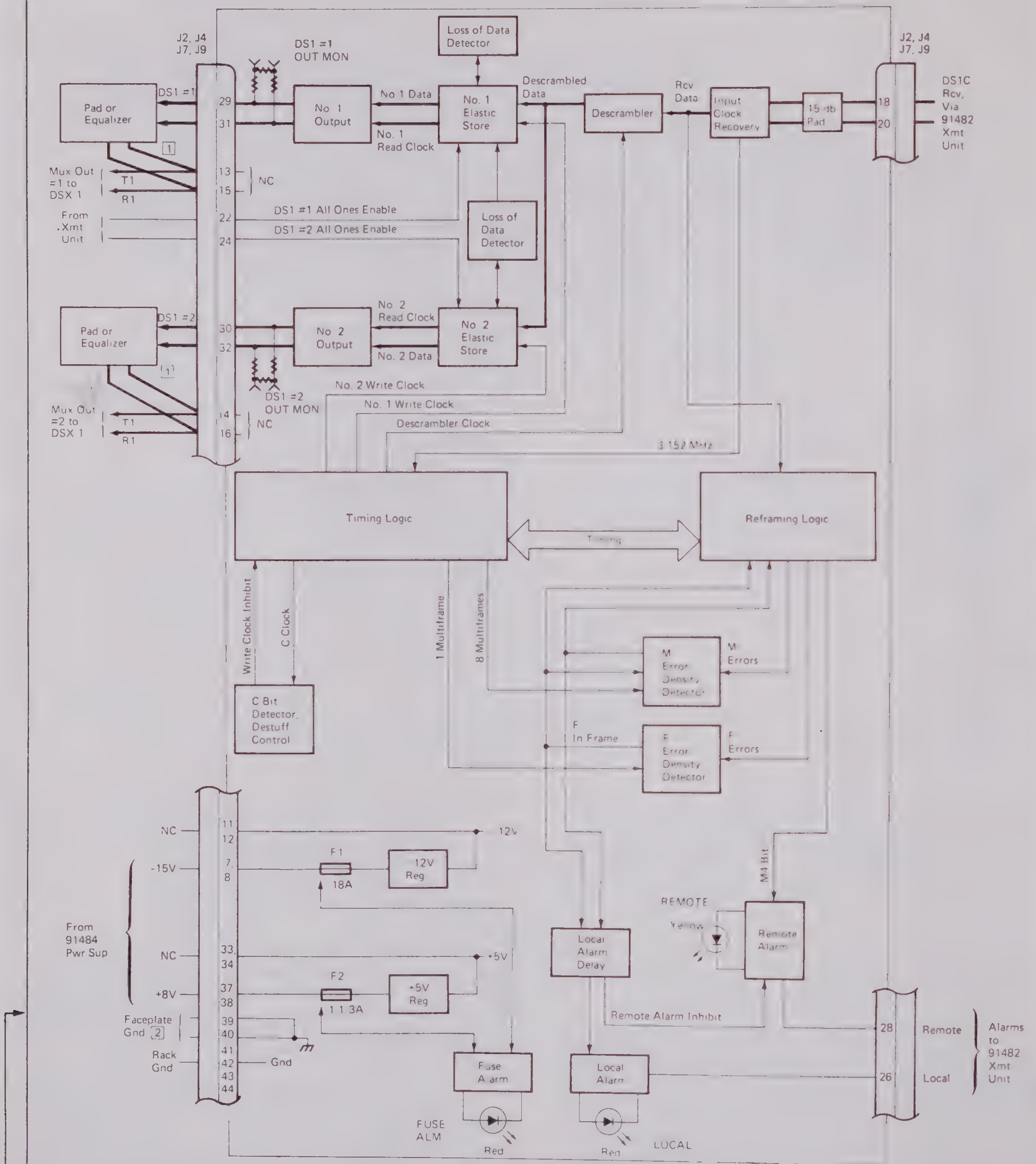
3.17 The unipolar data is retimed and processed through a descrambler circuit. The descrambled signal is applied to the elastic stores circuits for destuffing, removal of control bits, and demultiplexing into two signals at the DS1 rate.

3.18 The data bits are stored in each elastic store by a "write" clock generated for each channel by the timing circuits. Each elastic store generates a "read" clock for retrieval of the stored data. Gaps in the write clock (caused by deletions of the control bits and stuffed bits) are not present in the read clock, and the elastic stores produce data outputs at a smooth and uniform rate, identical to the DS1 inputs at the transmit end, except for the addition of a small amount of waiting time jitter. Loss-of-data detectors force the elastic stores to an all 1's output if the data goes to all 0's. This output is transmitted as a fault indication and keeps the DS1 lines energized.

3.19 In the final stage of the receive unit, the DS1 outputs of the elastic stores are converted from unipolar to bipolar format.

3.20 Timing Logic. Driven by the 3.152-MHz clock recovered from the incoming DS1C data, the timing circuits generate the internal timing signals required by the receiver. These include the write clocks and clocks timed to the F, M, and C control bits for use in frame monitoring, reframing, and destuffing circuits.

Figure 3-3. Block Diagram of 91483 Receive Unit


J2, J4
J7, J9
DS1 #1
OUT MON
Loss of Data
Detector
J2, J4
J7, J9
Pad or
Equalizer
DS1 #1
29
31
No 1
Output
No 1 Data
No. 1
Read Clock
No. 1
Elastic
Store
Descrambled
Data
Descrambler
Rcv
Data
Input
Clock
Recovery
15 db
Pad
18
20
DS1C
Rcv.
Via
91482
Xmt
Unit
1
Mux Out
#1 to
DSX 1
T1
R1
13
15
NC
From
Xmt
Unit
22
24
DS1 #1 All Ones Enable
DS1 #2 All Ones Enable
Loss of
Data
Detector
Pad or
Equalizer
DS1 #2
30
32
No 2
Output
No 2
Read Clock
No. 2 Data
No 2
Elastic
Store
1
DS1 #2
OUT MON
Mux Out
#2 to
DSX 1
T1
R1
14
16
NC
No. 2 Write Clock
No. 1 Write Clock
Descrambler Clock
3.152 MHz
Timing Logic
Timing
Reframing Logic
Write Clock Inhibit
C Clock
1 Multiframe
8 Multiframes
M
Error
Density
Detector
M
Errors
C Bit
Detector,
Destuff
Control
F
In Frame
F
Error
Density
Detector
F
Errors
NC
11
12
12V
-15V
7
8
F1
18A
12V
Reg
From
91484
Pwr Sup
NC
33
34
+5V
+8V
37
38
F2
1 1 3A
+5V
Reg
Faceplate
Gnd 2
39
40
Rack
Gnd
41
42
43
44
Gnd
M4 Bit
REMOTE
Yellow
Remote
Alarm
Local
Alarm
Delay
Remote Alarm Inhibit
28
26
Remote
Local
Alarms
to
91482
Xmt
Unit
Fuse
Alarm
Local
Alarm
FUSE
ALM
Red
Red
LOCAL

NOTE:

1 The DS1 signals at pins 29 and 31, 30 and 32 go through pads or equalizers on TB2 of the shelf and return to pins 13 and 15, 14 and 16, where multiplexer output connections are made at installation (refer to paragraph 6.14 and figure 7-1B).

2 Effective with unit issue 5.

3.21 Destuff Control. The 1's in the C time slots indicate stuffing of the data stream (paragraph 3.07); 0's in those slots indicate no stuffing. If stuffing is indicated, the demultiplexing clocks are inhibited at the stuffed time slot, causing the extra bit (inserted by stuffing) to be eliminated in the demultiplexing process.

3.22 Reframing Logic. Reframing ensures that the timing logic is synchronized with the frame format of the incoming DS1C signal.

3.23 With each error detected in the M or F pattern, an error pulse is registered in a respective error-density circuit. If three or more F errors are registered from the same multiframe, or three or more M errors from eight consecutive multiframes, the circuits recognize an out-of-frame pattern and the reframing circuits are activated. An in-frame condition is recognized in the occurrence of a complete multiframe without F errors, and eight consecutive multiframes without M errors.

3.24 The following alarm functions are performed by the receive unit.

3.25 Local Alarm Delay. The F in-frame and M in-frame leads (from the error density circuits) are combined at the input to the local alarm-delay circuit. An out-of-frame indication (logic 0) on either lead will cause the circuit to activate the local alarms after a delay of 200 milliseconds. Also, the circuit will inhibit the remote alarm function for the period that the out-of-frame condition is in effect.

3.26 Local Alarm. At the expiration of the delay period, a local alarm indicator (red LED) will operate. The alarm signal will also go to the transmit unit to activate the mux-alarm circuit at the near end and the mux and remote-alarm circuits at the far end.

3.27 Remote-Alarm Detector. This circuit samples the fourth M bit from the M-bit detector and provides an alarm output if the sampled bit is zero.

3.28 Remote Alarm. When activated, the remote-alarm circuit lights a visual REMOTE alarm indicator (yellow LED), provided that the circuit is not disabled by the presence of a local out-of-frame condition (paragraph 3.25). An alarm signal also goes to the transmit unit for activation of the mux-alarm circuits.

Alarm Functions

3.29 The 9122A Multiplexer provides audible and visual alarms for both local and remote failures. Figure 3-4 illustrates the sequence of the initiation and clearance of these alarms. The following visual and audible alarm functions are provided.

(a) Local Alarm. Indicates a failure detected at the near end of the system. A 200-millisecond delay will intervene between detection of the failure and activation of the alarm.

(b) Remote Alarm. Indicates a failure detected at the far end of the system.

(c) Fuse Alarm. Visual alarm on transmit and receive units.

(d) Power Alarm. Visual alarm on power supply unit indicates blown fuse in unit or drop to alarm threshold in the level of voltage output.

(e) Mux Alarm. Operates when any of the above alarms lasts for more than 1.0 ±0.5 seconds (with exception of a power alarm in a redundant power supply system). Activates office alarms.

3.30 The following alarm functions are performed by the transmit unit.

3.31 Alarm Combining. The alarm-combiner circuit is gated for local alarms, remote alarms, and fuse alarms from the transmit and receive units. The normal (no alarm) input is a logic 0 (ground); the alarm input is a logic 1. An alarm indication at any of the three inputs results in an alarm indication (logic 1) at the output of the circuit.

3.32 Time Delay. The time-delay circuit interposes a one-second delay between the time of receiving an alarm input (from the combiner) and the time of activating the alarms. This delay prevents office alarm activation by transient conditions. The circuit interposes a 3 second delay between the clearance and deactivation of alarms. This aids in identifying transient conditions lasting more than one second.

3.33 Visual and Audible Alarms. Output of the time delay circuit goes to audible and visual alarm driver circuits. An alarm signal will cause these gated circuits to turn on the MUX ALM lamp and change the visual and audible alarm outputs to the alarm mode (logic 1). The 91485 Alarm Panel provides relay circuits when it is desired to extend these logic outputs to office alarms.

3.34 Alarm Cutoff (ACO). Pressing the ACO switch will activate the aco circuit during an alarm condition. When activated, the circuit silences the office audible alarm, turns on the ACO LED, resets the mux-alarm latch (next paragraph), and enables the loop circuit (paragraph 3.36). With removal of the alarm condition, the aco circuit resets itself and cannot again be activated by the switch as long as the no-alarm condition continues.

3.35 Mux Alarm Latch (MEM). When its input from the time-delay circuit goes to an alarm state, the mux-alarm latch is activated and the MEM (memory) LED is lighted. The latch can be reset (and the LED extinguished) only by pressing the ACO switch. In the event of transient or intermittent alarms that clear themselves before a craftsperson can get to the equipment, the MEM lamp identifies the muldem where the alarms are occurring.

3.36 Loop Circuit. When activated, this circuit loops the DS1C output of the transmit unit back to the input of the receive unit. The circuit must first be enabled by pressing the ACO switch during an alarm condition; only then can the circuit be activated by pressing the LOOP switch. Activation turns on the green LOOP indicator LED. The circuit will deactivate only when the LOOP switch is pressed a second time to release it (a push-push switch).

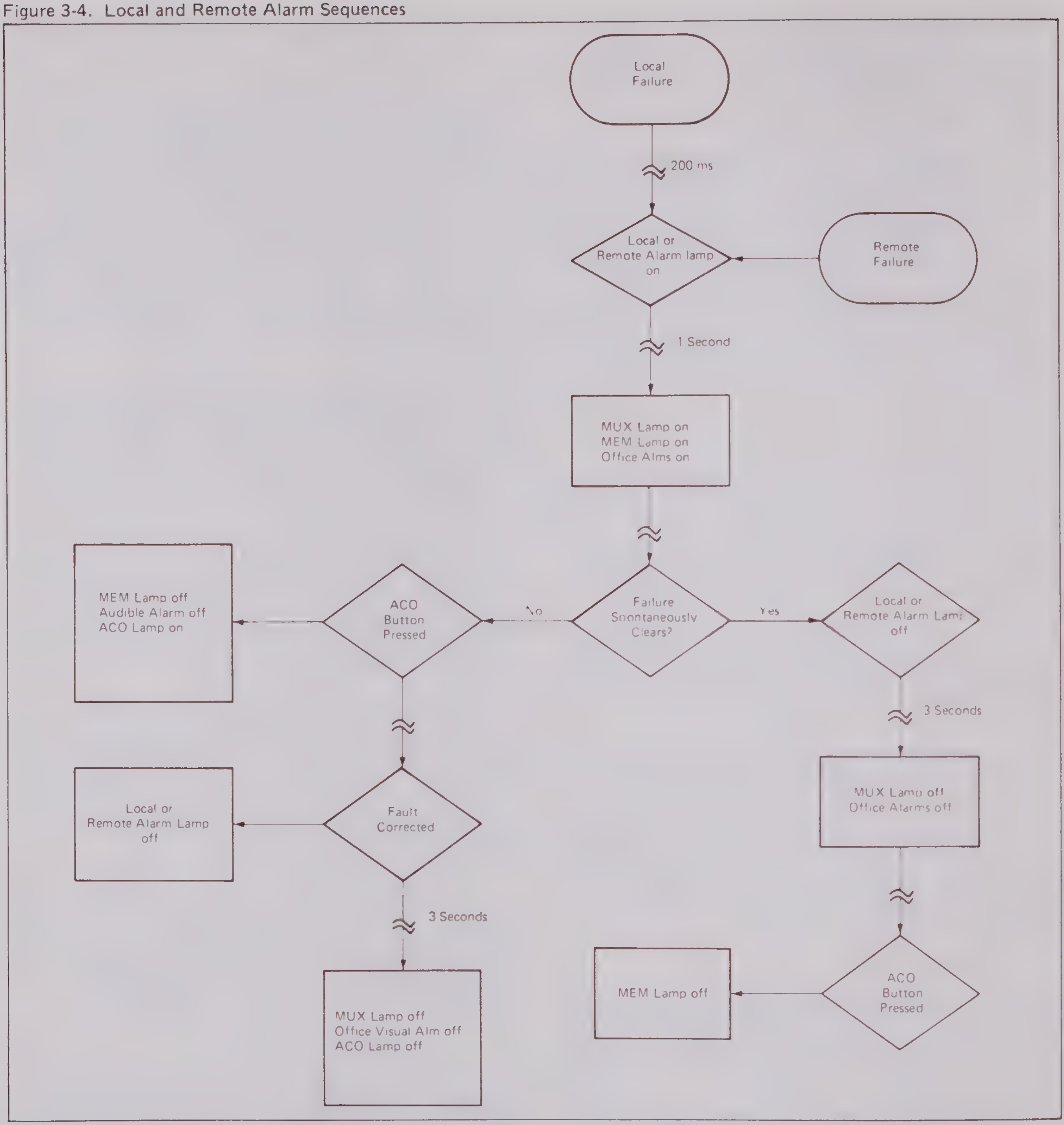
Power Supply Functions

3.37 91155 Fuse and Alarm Shelf. This shelf is schematically illustrated in figure 3-5. It fuses and distributes —48-volt source power to the 91485 Alarm Panel and to each 91481 shelf. Should a fuse blow, an alarm relay circuit shows a visual alarm and activates office alarm circuits (see also paragraphs 6.03-6.06).

3.38 91484 Power Supply Unit. A diagram of the 91484 Power Supply Unit is shown in figure 3-6. Operating from the —48 volt office battery, the unit employs a pulse-width modulated regulator to provide regulated voltages of +8 volts and —15 volts to the transmit and receive units, as shown in the diagram.

3.39 The muldem shelf makes provisions for two 91484 Power Supply Units. One unit is adequate to power one shelf equipped with four muldems (four transmit and four receive units). Two units are used in a parallel redundancy configuration for the protection it affords against service disruption through a power supply failure. Should either unit in a redundancy configuration fail, the

Figure 3-4. Local and Remote Alarm Sequences


Local Failure
200 ms
Local or Remote Alarm lamp on
Remote Failure
1 Second
MUX Lamp on
MEM Lamp on
Office Alms on
Failure Spontaneously Clears?
No
Yes
ACO Button Pressed
MEM Lamp off
Audible Alarm off
ACO Lamp on
Local or Remote Alarm Lamp off
3 Seconds
MUX Lamp off
Office Alarms off
Fault Corrected
Local or Remote Alarm Lamp off
3 Seconds
MUX Lamp off
Office Visual Alm off
ACO Lamp off
MEM Lamp off
ACO Button Pressed

other unit automatically takes the full load without affecting operation of the muldems in the shelf.

3.40 91485 Alarm Panel. A diagram of the alarm panel is shown in figure 3-7. The panel consists of a relay and relay-control circuits powered by —48 volts from the 91155 shelf. The relay-control circuits receive inputs via visual and audible alarm lead multiples connected to each muldem shelf. Should a transmit, receive, or power supply unit on any shelf fail, or should a span line failure be detected in a receive unit, the shelf's output to the alarm leads will go to an alarm mode (change from logic 0 to logic 1). Detection of the alarm will cause the normally-energized relay to release and transmit an alarm to the office equipment.

Jackfield and Cross-Connect Functions

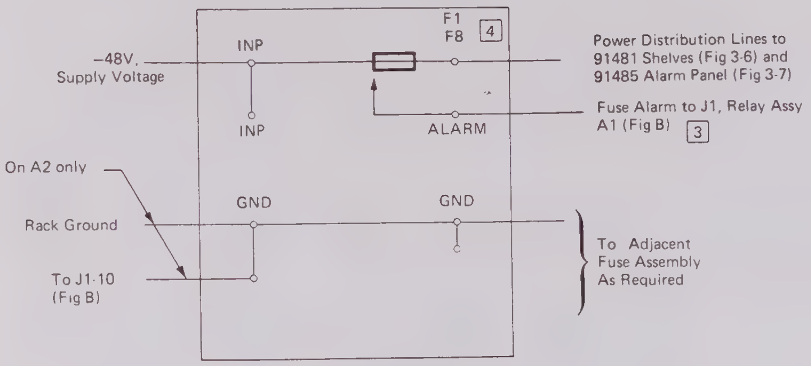
3.41 Standard 9122A Assemblies in prewired racks are offered with patching and cross-connect panels installed and wired in the rack. Functions of these panels are illustrated in figure 3-8.

3.42 Generally, the terms DS1, DS1C, DSX-1 and DSX-1C have reference to cross-connect panels and functions, and have the following meanings:

(a) DS1. Digital signal at the 1st level (1.544 Mb/s).
(b) DS1C. Digital signal at the 1-C level (3.152 Mb/s).
(c) DSX-1. A cross-connect at the DS1 level.
(d) DSX-1C. A cross-connect at the DSX-1C level.

Figure 3-5. 91155 Fuse and Alarm Shelf

Figure A. Fuse Assembly A2 through A7


F1
F8
4
INP
INP
ALARM
–48V.
Supply Voltage
Power Distribution Lines to 91481 Shelves (Fig 3-6) and 91485 Alarm Panel (Fig 3-7)
Fuse Alarm to J1, Relay Assy A1 (Fig B)
3
On A2 only
Rack Ground
To J1-10 (Fig B)
GND
GND
To Adjacent Fuse Assembly As Required

NOTES:

1. Assembly designations A1 through A7 are assigned from left to right as viewed from the front.
2. The total current drain of all fuse assemblies in the shelf should not exceed 40 amperes.
3. Connect ALARM terminal on A2 through A7 to J1-7
4. One fuse is shown as typical for F1 through F8. Alarm contacts are connected together.
5. Fuses are not furnished with the fuse assembly and must be ordered separately.
6. See Figure 7-3 for fuse types and ratings, and GTE Lenkurt Stock Numbers.

7 Rack and chassis grounds are connected together. If separarate grounds are required, remove the strap from pin 10 of J1 to the chassis ground lug.

Figure B. Relay Assembly A1

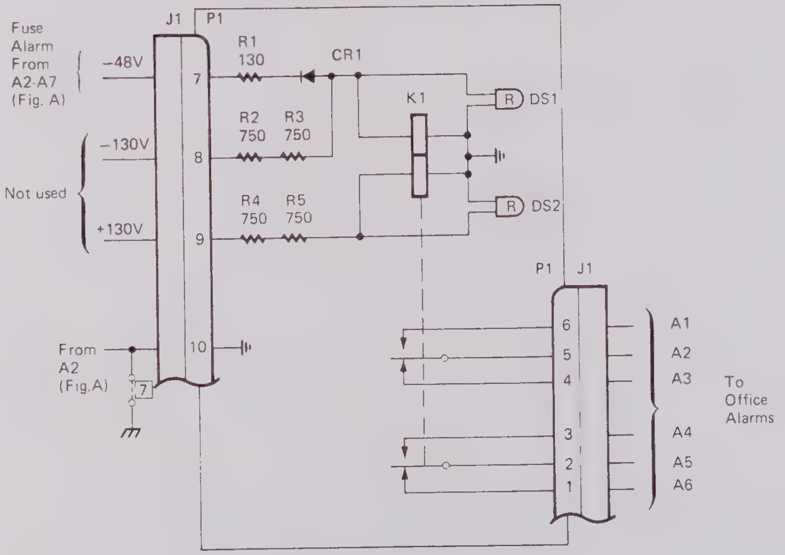

J1
P1
Fuse Alarm From A2-A7 (Fig. A)
–48V
7
R1
130
CR1
K1
R
DS1
–130V
R2
750
R3
750
8
Not used
+130V
R4
750
R5
750
9
R
DS2
P1
J1
From A2 (Fig.A)
10
7
6
5
4
3
2
1
A1
A2
A3
A4
A5
A6
To Office Alarms

Figure C. Pictorial View

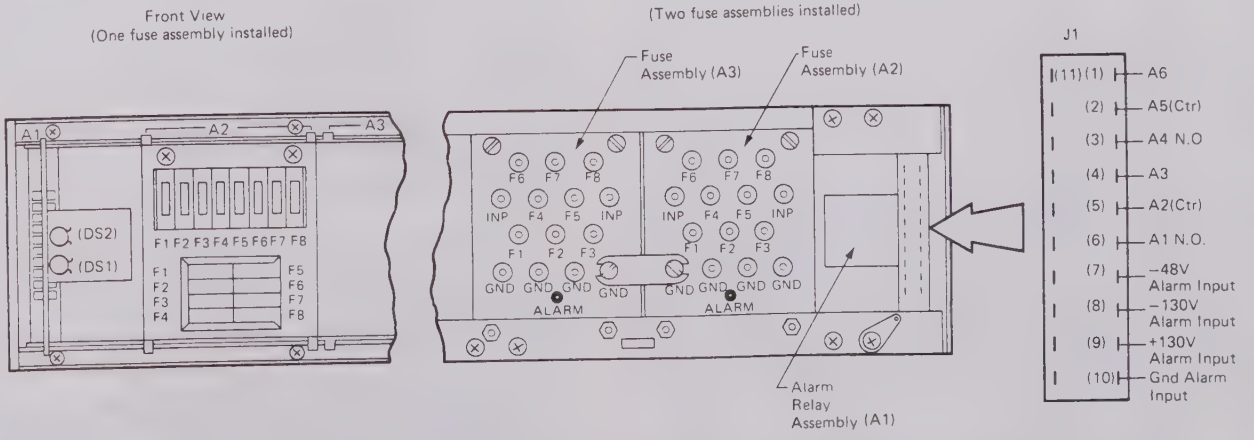
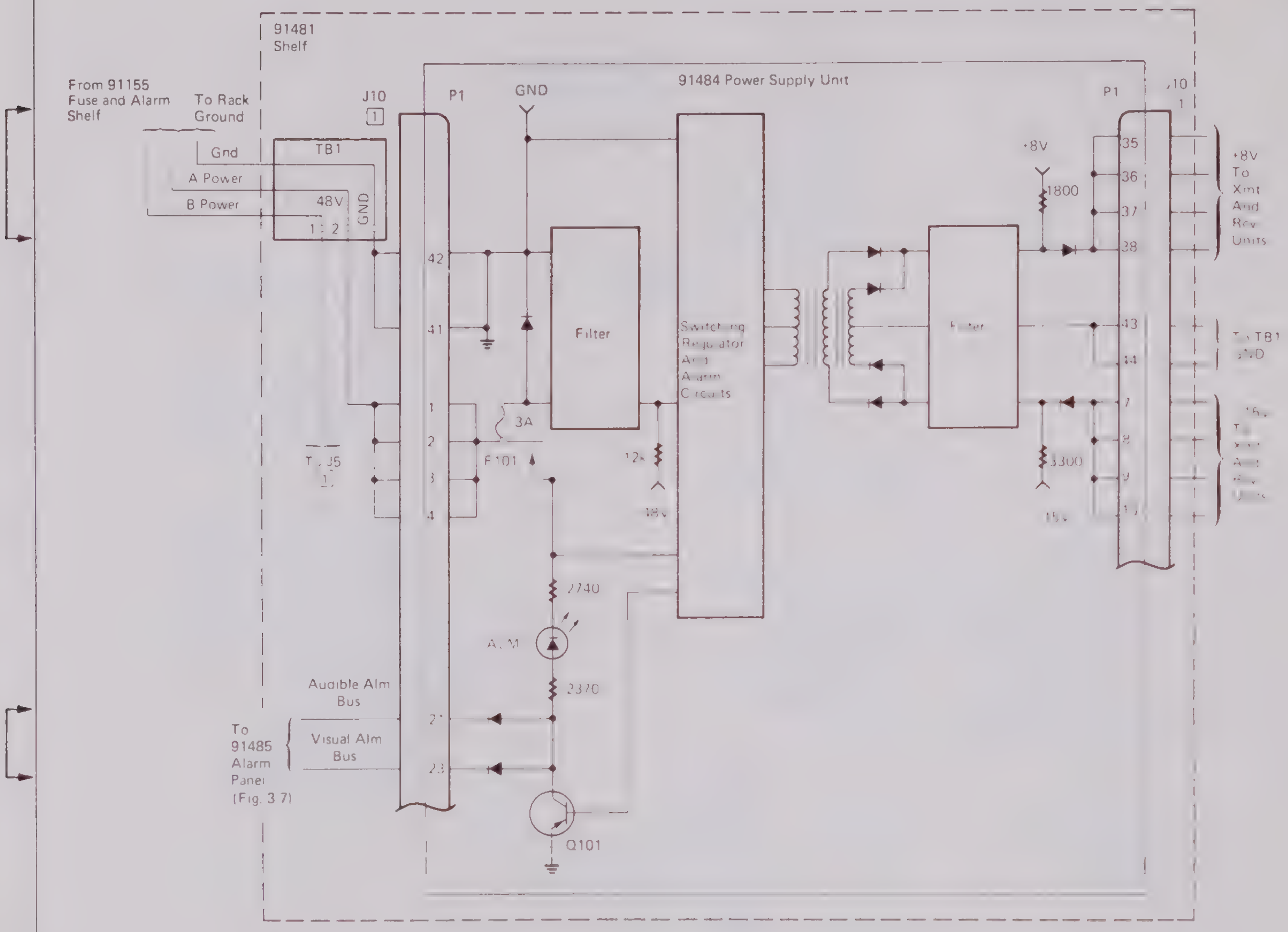

Front View
(One fuse assembly installed)
A1
A2
A3
(DS2)
(DS1)
F1 F2 F3 F4 F5 F6 F7 F8
F1
F2
F3
F4
F5
F6
F7
F8
Rear View
(Two fuse assemblies installed)
Fuse Assembly (A3)
Fuse Assembly (A2)
F6 F7 F8
INP F4 F5 INP
F1 F2 F3
GND GND GND GND
ALARM
Alarm Relay Assembly (A1)
J1
(11) (1) A6
(2) A5(Ctr)
(3) A4 N.O
(4) A3
(5) A2(Ctr)
(6) A1 N.O.
(7) –48V Alarm Input
(8) –130V Alarm Input
(9) +130V Alarm Input
(10) Gnd Alarm Input

Figure 3-6. Block Diagram of 91484 Power Supply Unit


91481
Shelf
From 91155
Fuse and Alarm
Shelf
To Rack
Ground
J10
1
P1
GND
91484 Power Supply Unit
P1
J10
1
Gnd
A Power
B Power
TB1
48V
GND
1 : 2
42
41
1
2
3
4
Filter
3A
F101
12k
18V
Switching
Regulator
And
Alarm
Circuits
Filter
+8V
1800
35
36
37
38
43
44
7
8
9
3300
+8V
To
Xmt
And
Rcv
Units
To TB1
GND
To J5
1
2740
ALM
2370
Audible Alm
Bus
Visual Alm
Bus
To
91485
Alarm
Panel
(Fig. 3-7)
22
23
Q101

NOTE

1 If two power supply units are used in redundant configuration, the units receive power from two 48V sources separately applied at TB1 1 and TB1 2. If a single power supply unit is used, install in J10 of shelf, if two units are used install in J5 and J10

3.43 The terms DSX-1 and DSX-1C are applicable to any of several available cross-connect panels. The two levels of cross-connect can be in the same panel, and need be segregated only as required for administrative purposes. One type of DSX-1 and DSX-1C cross-connect panel is the 163-10313-07, furnished as part of the 91211-21, -22, and -23 standard assemblies of the 9122A equipment.

3.44 As illustrated, the panels enable both DS1 and DS1C patching and cross connections. Permanent connections for the normal flow of traffic are made at the cross-connect panels. When maintenance is required on the normal path, traffic is diverted to a temporary path by patching it through at the jackfield, using mini-jack type patch cords. Figure 5-3 lists cross-connect cords available.

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4. ENGINEERING CONSIDERATIONS

Power Supplies

4.01 Generally, a single (non-redundant) 91484 Power Supply is used, except where all trunks in a route are in a single 91481 shelf or where the 9122A equipment is in an unattended office (see paragraph 3.39). Where redundant power supplies are used, it is recommended that power feeds also be redundant (see paragraphs 6.04-6.05).

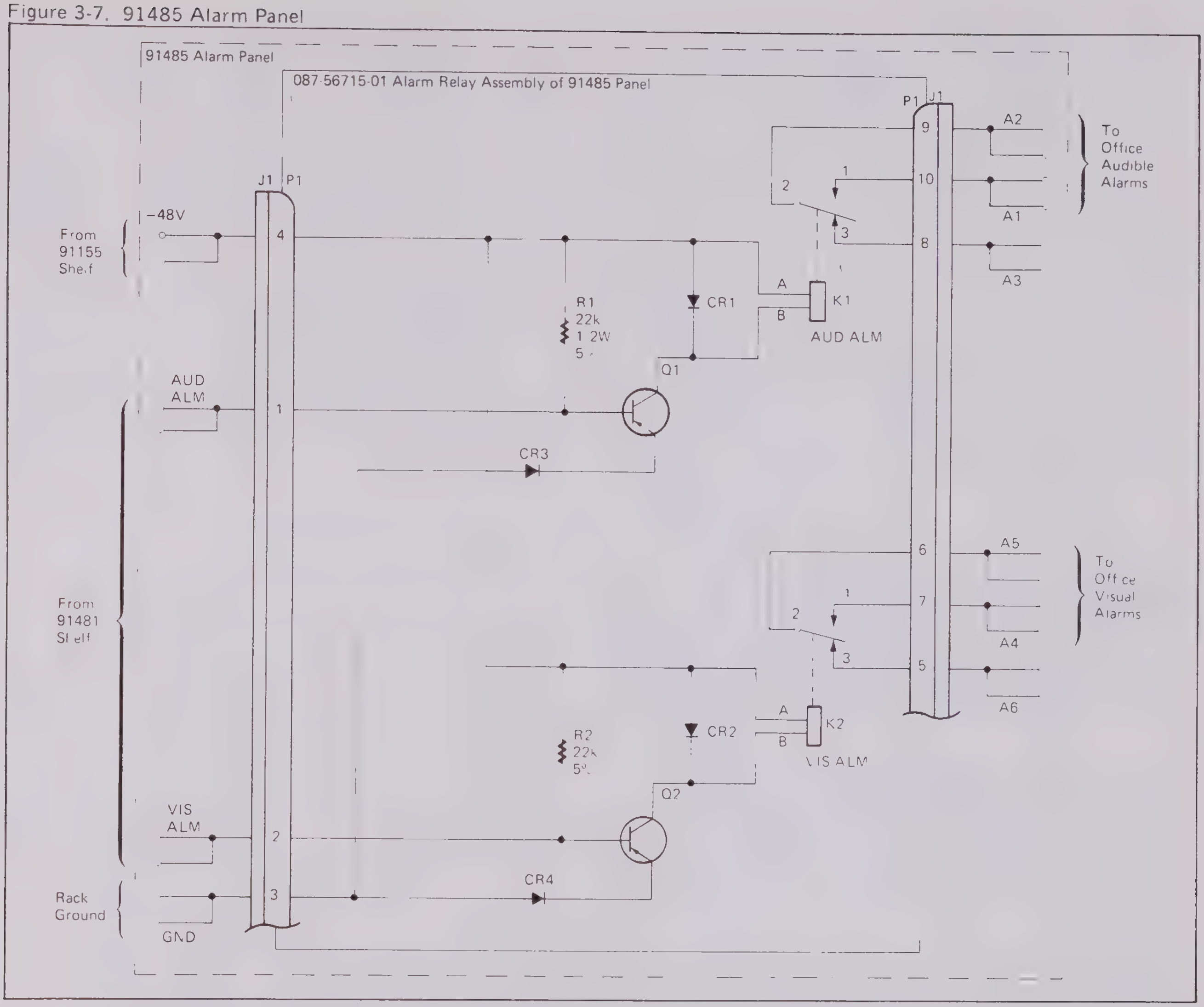
HF Cabling

4.02 The following types of cable or their equivalents are recommended for DS1 and DS1C signals:

(a) GTE Specification GTS-8507. This is a high-frequency terminating cable, manufactured by General Cable Corporation as type 4162 and containing individually shielded pairs as listed in figure 4-1A. Size offerings range from one to twelve pair maximum.

(b) GTE Specification GTS-8510 or Western Electric ABAM. This is a multipair cable having unshielded pairs within a common shield. It is manufactured by General Cable Corporation as type 4155 in sizes

Figure 3-7. 91485 Alarm Panel



ranging from two to 600 pairs. The GTE Lenkurt stock standard is a 12-pair cable and carries the GTE Lenkurt Part Number 163-10901-01. Figure 4-1B lists the most commonly used cable sizes.

4.03 With GTS-8507 cable, signals do not have to be segregated in different cables according to signal type and direction; however when multipaired, this cable can be cumbersome to work with because of the amount of shielding.

4.04 With GTS-8510 or ABAM cable, transmit and receive signals must be segregated in different cables because of inequalities in the transmit and receive signal levels in the longer office cables. Because the pairs are unshielded, only signals of equal level should be carried in a single cable of this type. Because of frequency difference, DS1 and DS1C signals should be carried in separate cables.

Cross-Connects

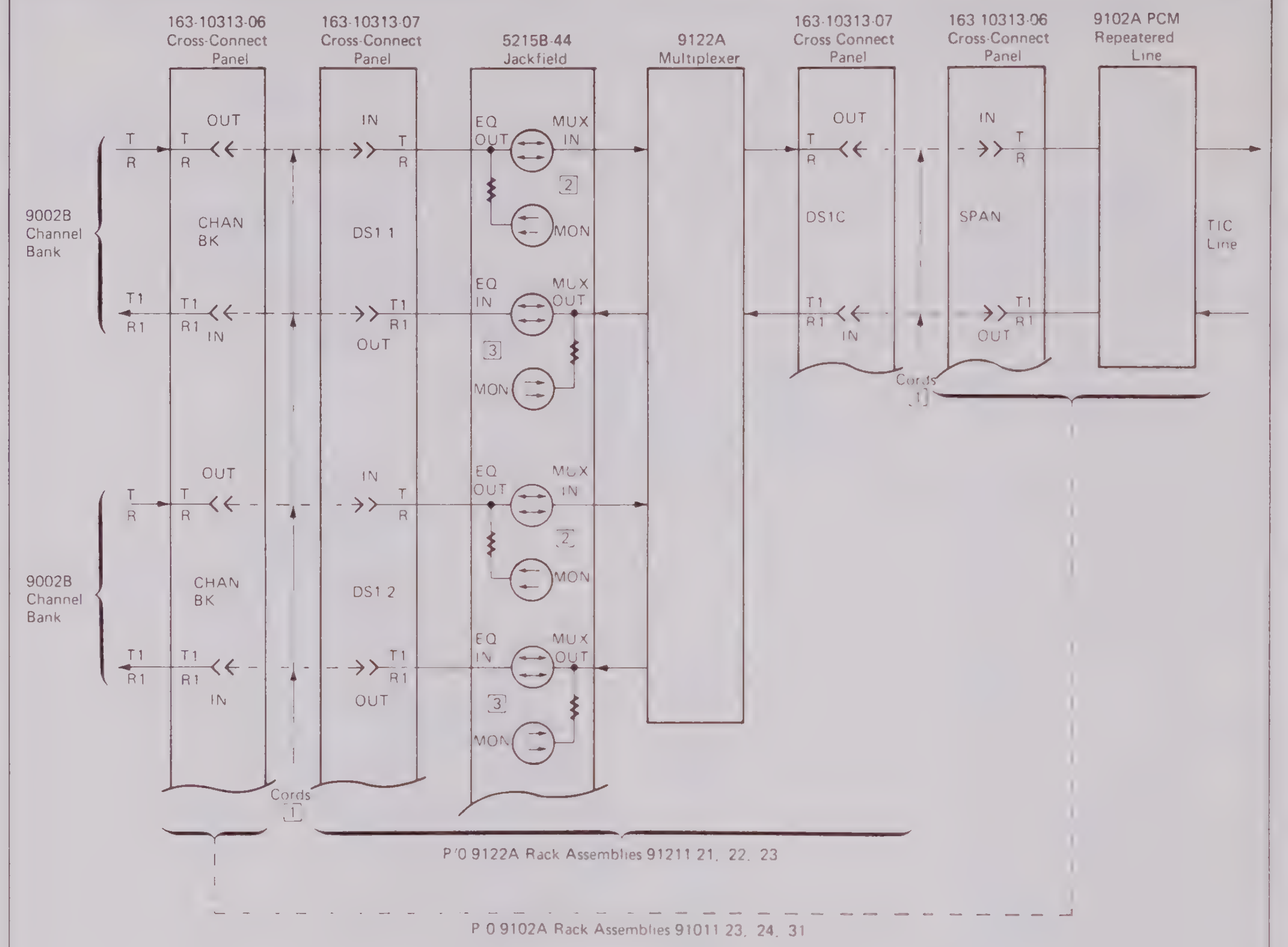
4.05 If separate cross-connect equipment with normal-through jacks for patching and testing is not provided, a jackfield and cross-connect panel on the associated equipment should be assigned to this function. The DSX-1 and DSX-1C cross-connects become especially important with longer office cables because patching is complicated by unequal transmit and receive levels at the equipment. Figure 4-2 shows the maximum cable lengths to the DSX-1 and DSX-1C cross-connects. Figure 5-3 lists patch cords and cables available.

4.06 Patching and restoration jacks are not provided on the 9122A equipment shelf. Where channel banks are collocated with the 9122A, a DSX-1 cross-connect is recommended since it would provide the only access to the channel bank interface. If alternate DS1 facilities are available for the DS1 lines, then access to them must be provided by patching and/or cross-connect facilities (refer to paragraph 3.41). Patching jacks for muldem and/or DS1C facility restoration are usually included with the span line equipment.

4.07 For longer lengths of cable, a pad in the multiplexer output (6-dB for DS1, 2-dB for DS1C) is replaced by an equalizer (figure 7-1). Similar equalizers are used on the DS1 outputs of the 91A Channel Banks and the DS1C outputs of the 91A Line Terminating Shelves; however, the channel bank and line terminating equalizers may be mechanically different from, and not interchangeable with, those used on the 9122A Multiplexer. Equalizers used on the 9148A Modified Duobinary Repeater Line Equipment are the same as those used on the 9122A.

4.08 The 91211-21, -22, and -23 assemblies of the 9122A (figure 5-1) are designed primarily for use with channel banks equipped with cross-connect panels. For use with channel banks not equipped with cross-connects, the 9122A assemblies can be equipped with a 163-10313-08 Cross-Connect Panel which will provide the necessary channel bank terminations (see figure 5-3).

Figure 3-8. Typical Cross-Connect and Patch


163-10313-06
Cross-Connect
Panel
163-10313-07
Cross-Connect
Panel
5215B-44
Jackfield
9122A
Multiplexer
163-10313-07
Cross Connect
Panel
163 10313-06
Cross-Connect
Panel
9102A PCM
Repeatered
Line
OUT
IN
EQ OUT
MUX IN
T
R
9002B
Channel
Bank
CHAN
BK
DS1 1
2
MON
EQ IN
MUX OUT
T1
R1
IN
OUT
3
DS1C
SPAN
TIC
Line
Cords
1
9002B
Channel
Bank
DS1 2
P/O 9122A Rack Assemblies 91211 21, 22, 23
P/O 9102A Rack Assemblies 91011 23, 24, 31

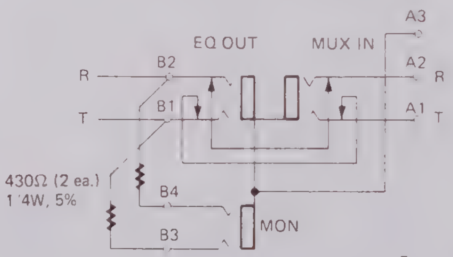
NOTES:

1 Figure 5 3 lists cords

2 See figure A and C for schematic

3 See figure B and C for schematic

2 Figure A. Left Side of 5215B-44 Jackfield


A3
EQ OUT
MUX IN
A2
R
B2
B1
A1
T
430Ω (2 ea.)
1/4W, 5%
B4
B3
MON

3 Figure B. Right Side of 5215B 44 Jackfield

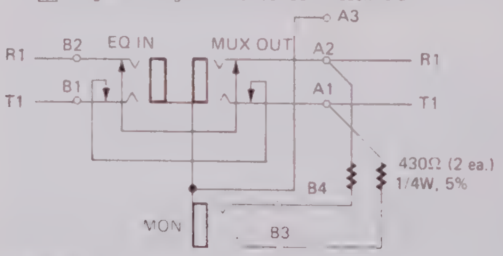

A3
R1
B2
EQ IN
MUX OUT
A2
T1
B1
A1
430Ω (2 ea.)
1/4W, 5%
B4
MON
B3

Figure C. Rear View of Triple Jack

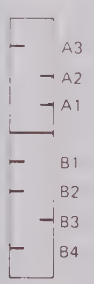

A3
A2
A1
B1
B2
B3
B4

Figure 4-1. GTS-8507 and 8510 Cables

Figure A. GTS-8507 Cables

GTE Lenkurt Part Number [1]	General Cable Type	Number Of Shielded Pairs
112-00153-05	4162A	1 pair
112-00153-06	4162B	5 pairs
112-00153-07	4162C	8 pairs
112-00153-08	4162D	10 pairs
112-00153-09	4162E	12 pairs

Figure B. GTS-8510 Cables

GTE Lenkurt Part Number [1]	General Cable Type 4155	Number of Pairs
163-10901-01	201212	12
163-10901-02	201226	26
163-10901-03	201251	51
163-10901-04	201280	101

NOTES:

[1] For 22AWG (0.63 MM)

WECo 206 Repeater Bay Partially E/W 9148A Office Repeaters

4.09 Two fully-equipped 9122A Multiplexer Equipment Shelves can be mounted in a Western Electric 206 Repeater Bay. For this application, the multiplexer shelves and alarm panel are installed in the space above and below the order wire and Telset panel in the 206 Repeater Bay. DSX-1 and DSX-1C cross-connects can usually be assigned to unused wire-wrap blocks in the bay cross-connect field. Power can be obtained through spare fuses in the fuse and alarm shelf. For 483- to 584-mm (19- to 23-inch) rack mounting adapters, see figure 5-3.

5. EQUIPMENT IDENTIFICATION AND ORDERING INFORMATION

Equipment Identification

5.01 Standard assembly arrangements of the 9122A Multiplexer, major components of the multiplexer, and optional auxiliary equipment for use with the multiplexer are listed, with brief descriptions and ordering numbers, in figures 5-1 through 5-3. The equipment included with standard assemblies is listed in figure 5-4. Profiles of the standard rack assemblies are shown in figure 5-5.

5.02 Figure 5-6 lists recommended test equipment for installation and maintenance of the 9122A equipment; figure 5-7, the replaceable components which are recommended to be stocked at an equipment site.

Ordering

5.03 Standard 9122A assemblies, components, and auxiliary equipment may be ordered by specifying ordering numbers and names as given in the figures, and/or by briefly describing the equipment and its required function. Orders for standard rack assemblies should specify a rack type and height as noted in figure 5-5.

5.04 Upon receiving an order, GTE Lenkurt will provide an acknowledgment and a scheduled shipping date. A list of all equipment included will accompany each shipment.

6. INSTALLATION

6.01 When equipment is received, inspect it carefully for damage. Claims for damage incurred in shipment should be reported at once directly to the transportation company in accordance with their instructions. If units were shipped in the shelf, they should be removed during the installation procedure until external connections have been made and verified.

General Considerations

6.02 91481 Equipment Shelf. The 91481 shelf occupies four mounting spaces or 178 mm (7 inches) on a standard 483-mm (19-inch) rack. When positioning the equipment, allow for a 127-mm (5-inch) projection from the front of the rack and a 152-mm (6-inch) projection from the rear. Space allotment must allow access to the rear of the shelf for installation and maintenance. Empty spaces for ventilation should be provided between shelves, as noted in figure 5-5.

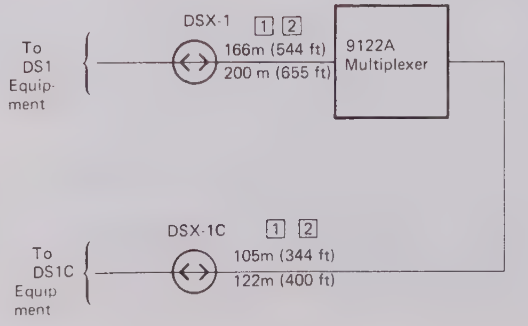
6.03 91155 Fuse and Alarm Shelf. This shelf is functionally illustrated in figure 6-2. Up to six fuse modules (A2 through A7) can be installed. Each module provides holders for eight fuses, power and ground input terminals, and crimping lugs for the connections of power and ground distribution lines. Power-commoning bus bars are provided for installation between fuse modules.

6.04 Redundant or non-redundant power can be applied to the 91155 shelf. In the redundant mode the shelf receives power from two sources (office batteries) via two feeders (A and B), as illustrated in figures 6-2A and 6-2B. Its advantage is protection against failure of one source or one feeder. The non-redundant mode uses a single source and feeder, as illustrated in figure 6-2C.

6.05 Regardless of how it receives power (from a redundant or non-redundant source), the 91155 shelf must feed power, over separate lines, to two power input terminals (TB1-1 and TB1-2) on each 91481 shelf. Figures 6-2A and 6-2B illustrate the distribution of redundant power to the shelves. Bus bars are installed between

(Text continues on page 24).

Figure 4-2. Maximum Cable Lengths to DSX-1 and DSX-1C Cross-Connects



NOTES:

[1] Maximum cable lengths shown above line for GTS-8507 cable; below line for GTS-8510 or ABAM cable.

[2] Signal flow is in both directions in diagram. Equalizers are used only on outputs of equipment. (See figure 7-1).

Figure 5-1. Standard Assembly Arrangements of the 9122A Multiplexer

Ordering Number	Assembly Description [1]
91211-01	A single, expandable, 9122A Muldem serving two DS1 terminations. Consists of equipment shelf with one transmit unit, one receive unit, and one (non-redundant) power supply unit. Second, third, and fourth muldems and redundant power supply require addition of plug-in transmit, receive, and power supply units. [2]
91211-02	Expansion package consisting of one transmit and one receive unit provides second, third, and fourth muldems for 91211-01 Assembly.
91211-03	Equipment shelf fully equipped with four muldems consisting of four transmit units, four receive units, and two power supply units (one redundant). [2]
91211-04	Provides all plug-in muldem and power supply units to fully equip one 91481 Muldem Shelf. Includes four 91482 Transmit Units, four 91483 Receive Units, and two 91484 Power Supply Units. Shelf not included.
91211-11	Assembly designed for use with DSX frames. Consists of six muldem shelves, power distribution fuse shelf, and alarm panel for interface to office alarms; all on a prewired 19-inch rack. Rack height optional, with minimum of 1.5 m (4 feet, 11.5 inch). Muldem and power supply plug-in units to be ordered separately, as required. [2] [3] [4]
91211-12	Same as 91211-11, except provides twelve muldem shelves, and minimum rack height is 2.84 m (9 feet, 4 inch).
91211-21	Assembly designed for central offices without DSX frames. Consists of three muldem shelves, power distribution fuse shelf, alarm panel for interface to office alarms, cross-connect and pan duct panels, jackfield; all on a prewired 19-inch rack. Rack height optional, with minimum of 1.6 m (5 feet, 3 inch). Muldem and power supply plug-in units to be ordered separately as required. [2] [3] [4]
91211-22	Same as 91211-21, except provides six muldem shelves and expanded jackfield; 1.9 m (6 feet, 5 inch) minimum rack height. [2] [3] [4]
91211-23	Same as 91211-22, except provides twelve muldem shelves and expanded jackfield. Minimum rack height is 3.2 m (10 feet, 6 inch). [2] [3] [4]
91211-30	For use with DSX frames. Consists of fourteen muldem shelves, power distribution fuse shelf, and alarm panel for interface to office alarms. All prewired and mounted on a 3.6-m (11 feet, 8 inch) unequal flange rack. Muldem and power supply plug-in units to be ordered separately as required. [2] [4]
91211-31	Same as 91211-30 except has eleven muldem shelves and mounted on a 2.7-m (9 foot) unequal flange rack. [2] [4]
91211-32	Same as 91211-30 except has nine muldem shelves and mounted on a 2.4-m (8 foot) unequal flange rack. [2] [4]
91484-01	Power Supply. Takes input from a —48 volt battery and provides regulated outputs of —15 volts and +8 volts. One unit will power a four muldem shelf. A second unit may be ordered and installed for a redundant power supply. Units plug into muldem shelf.

NOTES:

[1] See figure 5-2 for description of assembly components, and figure 5-4 for components provided with each assembly.

[2] If equalizers are required, specify ordering codes per figure 5-2.

[3] When ordering a rack assembly, specify rack height and type. See figure 1-1 for GTEP's covering racks.

[4] See figure 5-5 for profiles of rack assemblies.

Figure 5-2. Components of 9122A Multiplexer Assemblies

Ordering Number	Name	Description
91481-01	Muldem Equipment Shelf	Provides mounting facilities and interconnect wiring for up to four 9122A Muldems; i.e. four transmit units, four receive units, and two power supply units (one redundant).
Code CA, 91481-01	Equalizer, DS1	For use with 14 to 90 metres (46 to 294 feet) of GTS-8507 cable; or 17 to 108 metres (55 to 355 feet) of GTS-8510 or ABAM cable.
Code CB, 91481-01	Equalizer, DS1	For use with 90 to 166 metres (294 to 544 feet) of GTS-8507 cable; or 108 to 200 metres (355 to 655 feet) of GTS-8510 or ABAM cable.
Code CD, 91481-01	Equalizer, DS1C	For use with 35 to 70 metres (115 to 230 feet) of GTS-8507 cable; or 41 to 81 metres (133 to 266 feet) of GTS-8510 or ABAM cable.
Code CE, 91481-01	Equalizer, DS1C	For use with 70 to 105 metres (230 to 344 feet) of GTS-8507 cable; or 81 to 122 metres (266 to 400 feet) of GTS-8510 or ABAM cable.
91482-01	Transmit Unit	Performs multiplexing function of combining two DS1 inputs into a single DS1C output.
91483-01	Receive Unit	Performs demultiplexing function of separating a single DS1C input into two DS1 outputs.
91484-01	Power Supply Unit	Receives input from a —48 volt battery and provides regulated outputs of +8 —15 volts. One unit powers fully-equipped shelf; second unit provides redundant power.
91485-01	Alarm Panel	Provides relay circuits for interfacing 9122A alarm circuits with office alarms. One alarm panel serves a complete rack of 9122A equipment.
91155-01	Fuse and Alarm Shelf	Provides mounting for six Code A Fuse Modules. One fuse and alarm shelf serves complete rack of 9122A equipment.
Code A 91155-01	Fuse Module	Mounts on 91155-01 Fuse and Alarm Shelf, and provides for installation of eight GMT alarm type fuses for —48 volt power to 91485-01 Alarm Panel and 91481-01 Shelves.
024-55430-01	Pan Duct Panel	Provides housing for cross-connect jumpers.
5215B-44	Jackfield	Jacks for monitoring and patching DS1, DS1C signals of bay terminated channel banks and 9122A Muldems.
Code AC of 5215B	Extender Bracket	Brackets (2) for mounting single jackfield with a 105 mm (4-1/8 inch) front extension from rack. One required per jackfield.
163-10313-07	Cross-Connect Panel	Provides cross-connect facility for forty-eight 9122A muldems (DSX-1, DSX-1C).

Figure 5-3. Auxiliary Equipment

Ordering Number	Description	Required Quantity Per Bay
56620-01	Writing Shelf. Utility shelf for writing or other use. Takes one mounting space on 483 mm (19-inch) rack and is retractable when not in use.	1
EEH-40012-CK	Mounting Plate Extension Bracket. Used with EEH-40012-AM Adaptor Plate to install a 483-mm (19-inch) shelf on a 584-mm (23-inch) rack.	As required
EEH-40012-AM	Adapter Plate. Used with EEH-40012-CK Bracket to install a 483-mm (19-inch) shelf on a 584-mm (23-inch) rack.	As required
163-10313-08 ①	Cross-Connect Panel. Supplements cross-connect panels in interface equipment to 9122A Rack to provide an additional 75 channel bank terminations.	As required
163-10318-XX	Double-Contact Assy, Cross-Connect Cord, 24 AWG:	As required
-51	Orange, 0.3 m (1 foot)	
-52	Pink, 0.45 m (1.5 foot)	
-53	Red, 0.6 m (2 feet)	
-54	White, 0.76 m (2.5 feet)	
-55	Pastel Blue, 0.9 m (3 feet)	
-56	Black, 1.0 m (3.5 feet)	
-57	Yellow, 1.2 m (4 feet)	
-58	Brown, 1.4 m (4.5 feet)	
-59	Green, 1.5 m (5 feet)	
-60	Blue, 1.7 m (5.5 feet)	
-61	Tan, 1.8 m (6 feet)	
163-10318-99	T-Handle Removal Tool	1
6100C-01	Patch cord, two conductor shielded, T, R, S miniature plug at both ends, 1.5 m (5 feet) length.	6 of appropriate length per office
6100C-02	Same as 6100C-01 except 3 m (10 feet) length.	
6100C-03	Same as 6100C-01 except 0.6 m (2 feet) length.	

NOTE:

① Consult the engineering considerations of paragraphs 4.05 thru 4.08 for the applications requiring the 163-10313-08 cross-connect.

Figure 5-4. Equipment Furnished with Standard Assemblies

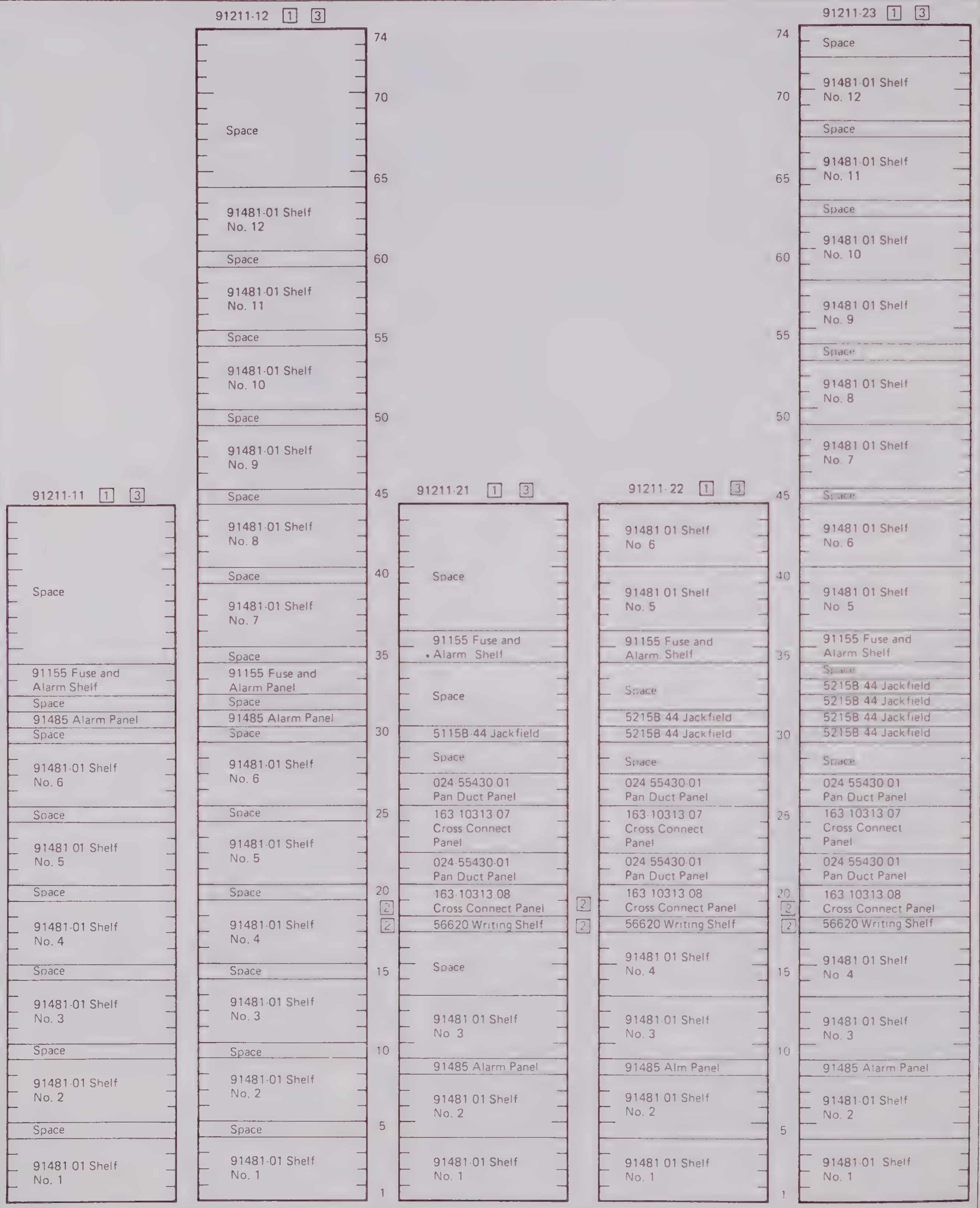
Equipment Ordering Number	Description	91211 — Assemblies											
		-01	-02	-03	-04	-11	-12	-21	-22	-23	-30	-31	-32
91481-01	Muldem Equipment Shelf	1		1		6	12	3	6	12	14	11	9
91482-01	Transmit Unit	1	1	4	4	①	①	①	①	①	①	①	①
91483-01	Receive Unit	1	1	4	4	①	①	①	①	①	①	①	①
91484-01	Power Supply Unit	1		2	2	②	②	②	②	②	②	②	②
91485-01	Alarm Panel					1	1	1	1	1	1	1	1
91155-01	Fuse and Alarm Shelf					1	1	1	1	1	1	1	1
Code A of 91155-01	Fuse Module					2	4	2	2	4	4	4	4
024-55430-01	Pan Duct Panel							2	2	2			
5215B-44	Jackfield							1	2	4			
Code A of 5215B-44	Extender Brackets							1	2	4			
163-10313-07	Cross-Connect Panel							1	1	1			
175-28996-10	Fuse, 5A GMT					12	24	6	12	24	28	22	18
175-28996-04	Fuse, 180MA GMT					1	1	1	1	1	1	1	1
31000-06	Unequal										1		
31000-02	Flange											1	
31000-04	Racks												1

NOTES:

① Order required transmit and receive units separately as assembly 91211-02.

② Order 91484-01 Power Supply Units separately as required.

Figure 5-5. Profiles of Standard Rack Assemblies (Sheet 1 of 2)


91211-11 [1] [3]
Space
91155 Fuse and Alarm Shelf
Space
91485 Alarm Panel
Space
91481-01 Shelf No. 6
Space
91481 01 Shelf No. 5
Space
91481-01 Shelf No. 4
Space
91481-01 Shelf No. 3
Space
91481-01 Shelf No. 2
Space
91481 01 Shelf No. 1
91211-12 [1] [3]
Space
91481-01 Shelf No. 12
Space
91481-01 Shelf No. 11
Space
91481-01 Shelf No. 10
Space
91481-01 Shelf No. 9
Space
91481-01 Shelf No. 8
Space
91481-01 Shelf No. 7
Space
91155 Fuse and Alarm Panel
Space
91485 Alarm Panel
Space
91481-01 Shelf No. 6
Space
91481-01 Shelf No. 5
Space
91481-01 Shelf No. 4
Space
91481-01 Shelf No. 3
Space
91481-01 Shelf No. 2
Space
91481-01 Shelf No. 1
74
70
65
60
55
50
45
40
35
30
25
20
15
10
5
1
91211-21 [1] [3]
Space
91155 Fuse and Alarm Shelf
Space
5115B-44 Jackfield
Space
024-55430-01 Pan Duct Panel
163-10313-07 Cross Connect Panel
024-55430-01 Pan Duct Panel
[2] 163-10313-08 Cross Connect Panel
[2] 56620 Writing Shelf
Space
91481 01 Shelf No 3
91485 Alarm Panel
91481 01 Shelf No. 2
91481-01 Shelf No. 1
91211-22 [1] [3]
91481 01 Shelf No 6
91481 01 Shelf No. 5
91155 Fuse and Alarm Shelf
Space
5215B 44 Jackfield
5215B 44 Jackfield
Space
024 55430-01 Pan Duct Panel
163-10313-07 Cross Connect Panel
024 55430-01 Pan Duct Panel
[2] 163 10313 08 Cross Connect Panel
[2] 56620 Writing Shelf
91481 01 Shelf No. 4
91481-01 Shelf No. 3
91485 Alm Panel
91481 01 Shelf No. 2
91481 01 Shelf No. 1
91211-23 [1] [3]
Space
91481-01 Shelf No. 12
Space
91481-01 Shelf No. 11
Space
91481 01 Shelf No. 10
91481 01 Shelf No. 9
Space
91481 01 Shelf No. 8
91481 01 Shelf No. 7
Space
91481 01 Shelf No. 6
91481 01 Shelf No 5
91155 Fuse and Alarm Shelf
Space
5215B 44 Jackfield
5215B 44 Jackfield
5215B 44 Jackfield
5215B 44 Jackfield
Space
024 55430 01 Pan Duct Panel
163 10313 07 Cross Connect Panel
024 55430 01 Pan Duct Panel
[2] 163 10313 08 Cross Connect Panel
[2] 56620 Writing Shelf
91481 01 Shelf No 4
91481 01 Shelf No. 3
91485 Alarm Panel
91481-01 Shelf No. 2
91481-01 Shelf No. 1

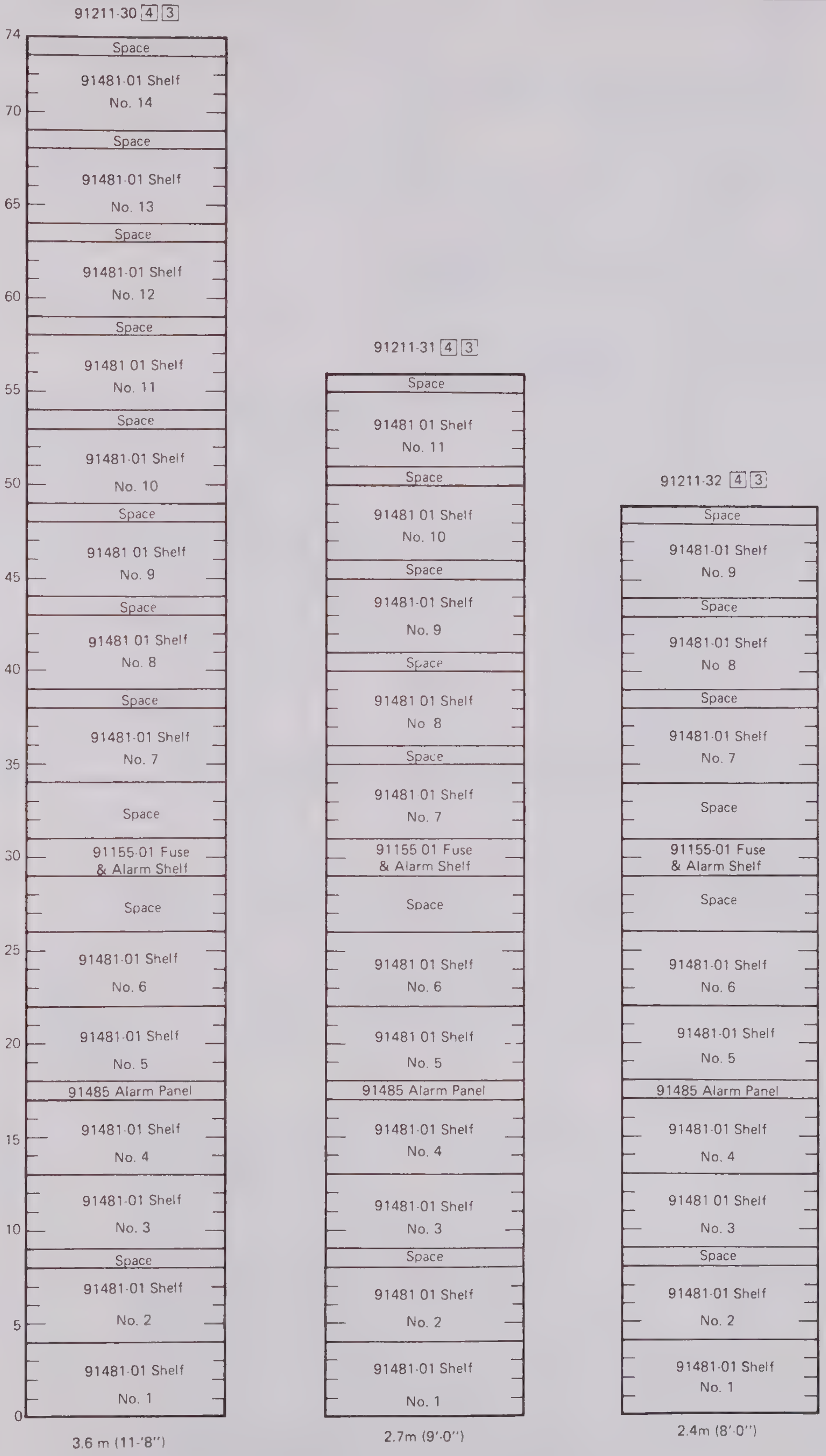
NOTES.

[1] Consult figure 5-1 for the minimum rack height in each configuration.

[2] In assemblies 91211-21, -22, and -23, the 163-10313-08 Cross-Connect Panel and the 56620-01 Writing Shelf are not included, but must be ordered separately. Refer to paragraph 4.10 for application of the 163-10313-08 Cross-Connect.

[3] Empty rack mounting spaces permit air circulation and prevent heat buildup. Where space permits, leave one empty mounting space at the top and bottom of each muldem shelf. Where space is limited, one empty space between each group of three shelves is acceptable.

Figure 5-5. Profiles of Standard Rack Assemblies (Sheet 2 of 2)


91211-30 4 3
74
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Space
91481-01 Shelf No. 14
Space
91481-01 Shelf No. 13
Space
91481-01 Shelf No. 12
Space
91481 01 Shelf No. 11
Space
91481-01 Shelf No. 10
Space
91481 01 Shelf No. 9
Space
91481 01 Shelf No. 8
Space
91481-01 Shelf No. 7
Space
91155-01 Fuse & Alarm Shelf
Space
91481-01 Shelf No. 6
91481-01 Shelf No. 5
91485 Alarm Panel
91481-01 Shelf No. 4
91481-01 Shelf No. 3
Space
91481-01 Shelf No. 2
91481-01 Shelf No. 1
3.6 m (11-'8")
91211-31 4 3
Space
91481 01 Shelf No. 11
Space
91481 01 Shelf No. 10
Space
91481-01 Shelf No. 9
Space
91481 01 Shelf No 8
Space
91481 01 Shelf No. 7
91155 01 Fuse & Alarm Shelf
Space
91481 01 Shelf No. 6
91481 01 Shelf No. 5
91485 Alarm Panel
91481-01 Shelf No. 4
91481-01 Shelf No. 3
Space
91481 01 Shelf No. 2
91481-01 Shelf No. 1
2.7m (9'-0")
91211-32 4 3
Space
91481-01 Shelf No. 9
Space
91481-01 Shelf No 8
Space
91481-01 Shelf No. 7
Space
91155-01 Fuse & Alarm Shelf
Space
91481-01 Shelf No. 6
91481-01 Shelf No. 5
91485 Alarm Panel
91481-01 Shelf No. 4
91481 01 Shelf No. 3
Space
91481-01 Shelf No. 2
91481-01 Shelf No. 1
2.4m (8'-0")

NOTE:

4 The 91211-30, -31, and -32 arrangements include the appropriate unequal flange rack. All shelves are rear mounted (facing toward the front). See figure 5-4 for racks.

Figure 5-6. Recommended Test Equipment

Quantity Per Site	Test Equipment	Description and Use
1 [1]	Bowmar 273A Digital Carrier Analysis Test Set (DS1 and DS1C outputs)	For multiplexer DS1 input-output, out-of-service end-to-end, or loop-back testing. For SA1C testing of 9148A duobinary 48-channel repeatered line, out-of-service, bit-error rate.
1	Simpson 260-6 Volt-Ohm-Milliammeter	General purpose multimeter with 20,000 ohms/volt sensitivity.
3	GTE Lenkurt 6100D-02 Test Cord	Shielded two-conductor cable, 3m (10 feet) in length, with 310-type TRS plug on one end and miniature TRS plug on other end. For patching 273A test set to DS1 IN and MON jacks.
1	GTE Lenkurt 729A Test Cord	310-type TRS to twin-pin plug for connecting 273A test set to DS1 OUT MON jacks.

NOTES:

[1] WECo KS20775, LI and Bowmar 271A test sets can also be used, except that they cannot be used for testing DS1C 48-channel span lines independently of other equipment at each end of the span.

2. Other test equipment may be substituted provided that all test requirements and performance capabilities are met.

3. Section 032-201-150 gives a complete listing of GTE Lenkurt standard plugs, adapters, and cords available for patching, testing, and maintenance of the equipment.

Figure 5-7. Recommended Spare and Replaceable Parts

Item	GTE Lenkurt Type or Stock Number	Recommended Spares
Transmit Unit	91482-01	One per each three fully-equipped muldem shelves. Minimum of one.
Receive Unit	91483-01	One per each three fully-equipped muldem shelves. Minimum of one.
Power Supply Unit	91484-01	One per each ten fully-equipped muldem shelves. Minimum of one.
Alarm Relay Assembly	087-56715-01	One per office.
Fuse, GMT 1.3A	175-28996-02 [1]	Ten per office.
Fuse, GMT 3.0A	175-28996-07 [2]	Ten per office.
Fuse, GMT 5.0A	175-28996-10 [3]	Ten per office.
Fuse, GMT 0.18A	175-28996-04 [1] [3]	Ten per office.
91481 Shelf Resistors R1, 13Ω R2, 931Ω R5, 37.4Ω R6, 316Ω R49, 162Ω	 161-01332-00 161-09313-00 161-03742-00 161-03163-00 161-01623-00	One each per office.
DS1 Equalizers	As applicable per figure 5-2	One per office (if used).
DS1C Equalizers	As applicable per figure 5-2	One per office (if used).

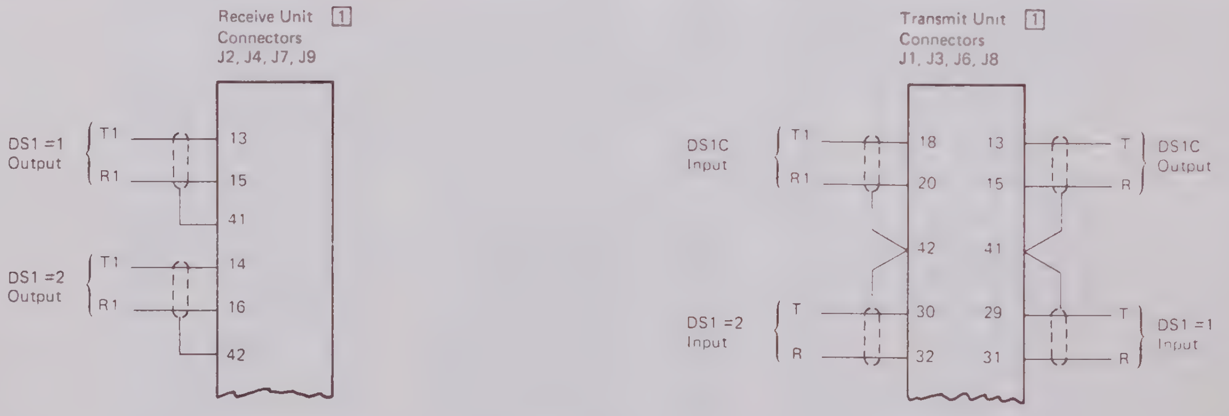
NOTES:

[1] Used on 91482 Transmit and 91483 Receive Units.

[2] Used on 91484 Power Supply Unit.

[3] Used on 91155 Fuse and Alarm Shelf.

Figure 6-1. DS1 and DS1C Installation Connections, 91481 Equipment Shelf



NOTES:

[1] Shelf connectors are J1 through J10, from right to left, viewed from rear of shelf.

[2] Incoming DS1C goes to the receive unit via contacts of relay K1 in the transmit unit (see figure 3-2, sheet 2).

Figure 6-2. Power Distribution to 91485 Panel and 91481 Shelves

Figure A. Assemblies With Seven or Less Shelves and Redundant Power Feeds

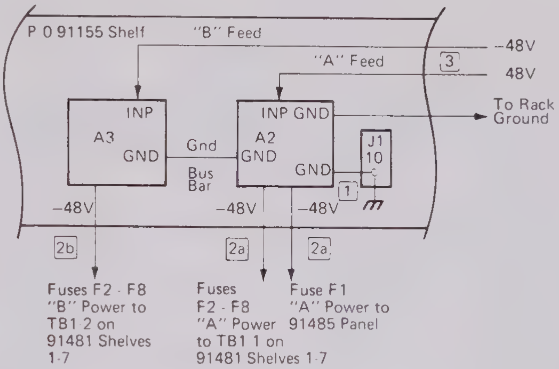

P 0 91155 Shelf
"B" Feed
"A" Feed
3
–48V
48V
To Rack Ground
INP
A3
GND
Gnd
Bus Bar
INP GND
A2
GND
GND
J1
10
1
–48V
–48V
–48V
2b
2a
2a
Fuses F2 - F8 "B" Power to TB1 2 on 91481 Shelves 1-7
Fuses F2 - F8 "A" Power to TB1 1 on 91481 Shelves 1-7
Fuse F1 "A" Power to 91485 Panel

Figure B. 91211-30 Assembly (With Redundant Power Feeds)

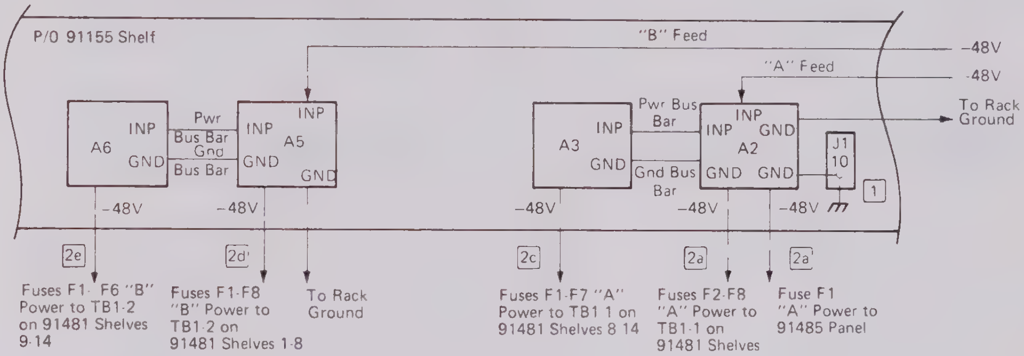
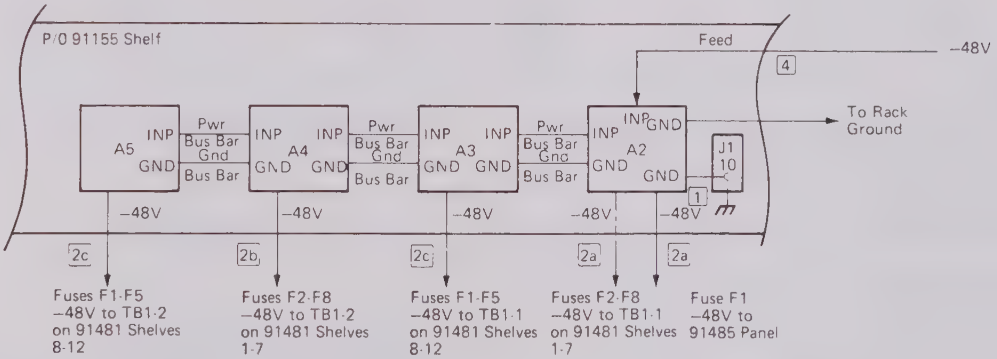

P/0 91155 Shelf
"B" Feed
"A" Feed
–48V
-48V
To Rack Ground
A6
INP
GND
Pwr
Bus Bar
Gnd
Bus Bar
INP
INP
A5
GND
GND
A3
INP
GND
Pwr Bus Bar
Gnd Bus Bar
INP
INP GND
A2
GND GND
J1
10
1
–48V
–48V
–48V
–48V
–48V
2e
2d
2c
2a
2a
Fuses F1- F6 "B" Power to TB1-2 on 91481 Shelves 9-14
Fuses F1-F8 "B" Power to TB1-2 on 91481 Shelves 1-8
To Rack Ground
Fuses F1-F7 "A" Power to TB1 1 on 91481 Shelves 8 14
Fuses F2-F8 "A" Power to TB1-1 on 91481 Shelves 1 7
Fuse F1 "A" Power to 91485 Panel

Figure C. 91211-12 or -23 Assemblies (With Non-Redundant Power Feed) *


P/0 91155 Shelf
Feed
–48V
4
To Rack Ground
A5
INP
GND
Pwr
Bus Bar
Gnd
Bus Bar
INP
INP
A4
GND
GND
Pwr
Bus Bar
Gnd
Bus Bar
INP
INP
A3
GND
GND
Pwr
Bus Bar
Gnd
Bus Bar
INP
INP
GND
A2
GND
GND
J1
10
1
–48V
–48V
–48V
–48V
–48V
2c
2b
2c
2a
2a
Fuses F1-F5 –48V to TB1-2 on 91481 Shelves 8-12
Fuses F2-F8 –48V to TB1-2 on 91481 Shelves 1-7
Fuses F1-F5 –48V to TB1-1 on 91481 Shelves 8-12
Fuses F2-F8 –48V to TB1-1 on 91481 Shelves 1-7
Fuse F1 –48V to 91485 Panel

NOTES:

1 Rack and chassis grounds are connected together. If separate grounds are required, remove the strap from pin 10 of J1 to the chassis ground lug.

2 Fuse Assignments:

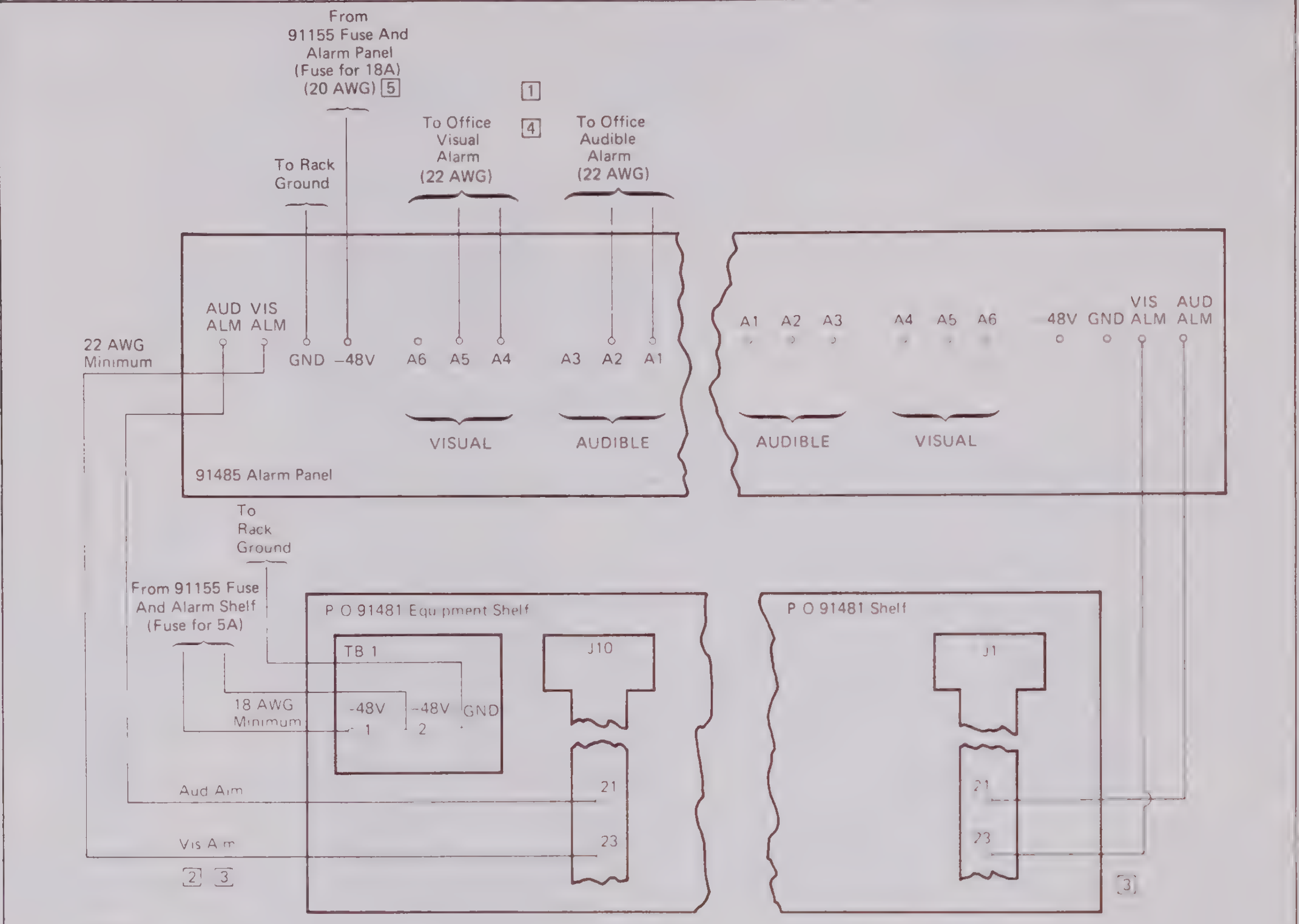
Fuse No.	Note No.				
	2a	2b	2c	2d	2e
	91481 Shelf No.				
F1	91485	NC	8	1	9
F2	1	1	9	2	10
F3	2	2	10	3	11
F4	3	3	11	4	12
F5	4	4	12	5	13
F6	5	5	13	6	14
F7	6	6	14	7	NC
F8	7	7	NC	8	NC

NC = No Connection

3 For non-redundant power, remove –48V input from A3 module and install power bus bar between A2 and A3 modules.

4 For redundant power, add separate –48V input to module A4 and remove power bus bar between modules A3 and A4.

Figure 6-3. Power and Alarm Wiring to 91485 Alarm Panel and 91481 Shelves


From 91155 Fuse And Alarm Panel (Fuse for 18A) (20 AWG) 5
1
4
To Office Visual Alarm (22 AWG)
To Office Audible Alarm (22 AWG)
To Rack Ground
AUD ALM
VIS ALM
GND
−48V
A6 A5 A4
A3 A2 A1
VISUAL
AUDIBLE
22 AWG Minimum
91485 Alarm Panel
A1 A2 A3
A4 A5 A6
48V GND VIS ALM AUD ALM
AUDIBLE
VISUAL
To Rack Ground
From 91155 Fuse And Alarm Shelf (Fuse for 5A)
18 AWG Minimum
P O 91481 Equipment Shelf
TB 1
-48V 1
-48V 2
GND
J10
21
23
Aud Alm
Vis Alm
2 3
P O 91481 Shelf
J1
21
23
3

NOTES

1 Absence of -48V input causes both visual and audible alarms. Unplug relay assembly on rear of 91485 01 Panel to silence alarm during installation.

2 The AUD ALM and VIS ALM leads are multipled (in parallel) to each 91481 shelf on the rack.

3 Connections are made at left side of shelf (J10) or at right side (J1)

4 Connections shown are for normally-open office alarm circuits (see paragraph 6.15(b)

5 Power input to 91485 Panel is from power feed A, never from power feed B (see figure 6 2)

(Continued from page 17.)

fuse modules so as to common the A power for application to shelf terminals TB1-1 and the B power for application to shelf terminals TB1-2. Figure 6-2C illustrates the distribution of non-redundant power. The power-commoning bus bars are installed between all fuse modules, and power is fed over separate lines to TB1-1 and TB1-2 on each shelf.

6.06 It is recommended that the 91155 shelf be installed at the top of the equipment rack. Separate power runs with individual fusing should then be made to each 91481 shelf (multipled power connections should be avoided). The shelf should be used exclusively for the rack in which it is installed and not shared by adjacent racks.

6.07 91485 Alarm Panel. The alarm panel occupies one mounting space or 44 mm (1.75 inches) on a standard 483-mm (19-inch) rack. A 140-mm (5.5 inch) projection from the rear of the rack provides for installation wiring. Two identical sets of terminals for installation wiring are provided. Both sets may be used for multiple alarm connections. Only one power input is required.

6.08 It is recommended that the 91485 panel be installed directly below the 91155 Fuse and Alarm Shelf. Its use should be limited to the rack on which it is installed. Alarm leads from wire-wrap posts on the panel should be multiple connected to the alarm output terminals on each 91481 shelf as described in paragraph 6.15.

6.09 91484 Power Supply Unit. A single, non-redundant 91484 unit will generate more heat than either of two units in redundant configuration. To minimize heat buildup, it is recommended that a non-redundant power supply unit be installed in J10 at the extreme right of the 91481 ahelf (front view). Muldem units should be installed starting from the extreme left, in order to allow maximum air circulation between the power supply and the muldems.

Pads and Equalizers

6.10 The DS1C outputs from the transmit units and the DS1 outputs from the receive units must enter the cable through a pad or equalizer selected according to the length of the cable. (See figures 4-2 and 7-1).

6.11 A terminal board TB2 is mounted at the rear and towards the top of each shelf. TB2 provides a 6-dB pad for each DS1 output, a 2-dB pad for each DS1C output, and mounting spaces for any required equalizers. Since the

Figure 7-1. 91481 Shelf Wiring Diagram (Sheet 1 of 2)

Figure A Power and Alarm Wiring of 91481 Shelf (Rear View)

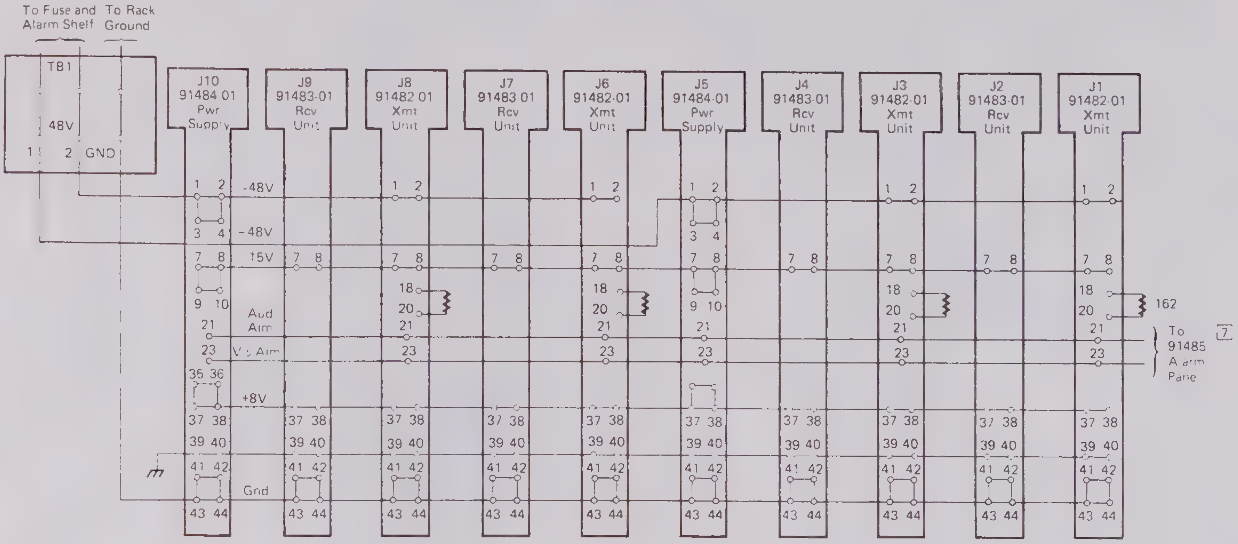

To Fuse and Alarm Shelf
To Rack Ground
TB1
48V
1
2
GND
J10 91484-01 Pwr Supply
J9 91483-01 Rcv Unit
J8 91482-01 Xmt Unit
J7 91483-01 Rcv Unit
J6 91482-01 Xmt Unit
J5 91484-01 Pwr Supply
J4 91483-01 Rcv Unit
J3 91482-01 Xmt Unit
J2 91483-01 Rcv Unit
J1 91482-01 Xmt Unit
-48V
-48V
15V
Aud Alm
Vis Alm
+8V
Gnd
1 2
3 4
7 8
9 10
18
20
21
23
35 36
37 38
39 40
41 42
43 44
162
To 91485 Alarm Panel
7

Figure B Wiring of Muldem No. 1 (Typical)

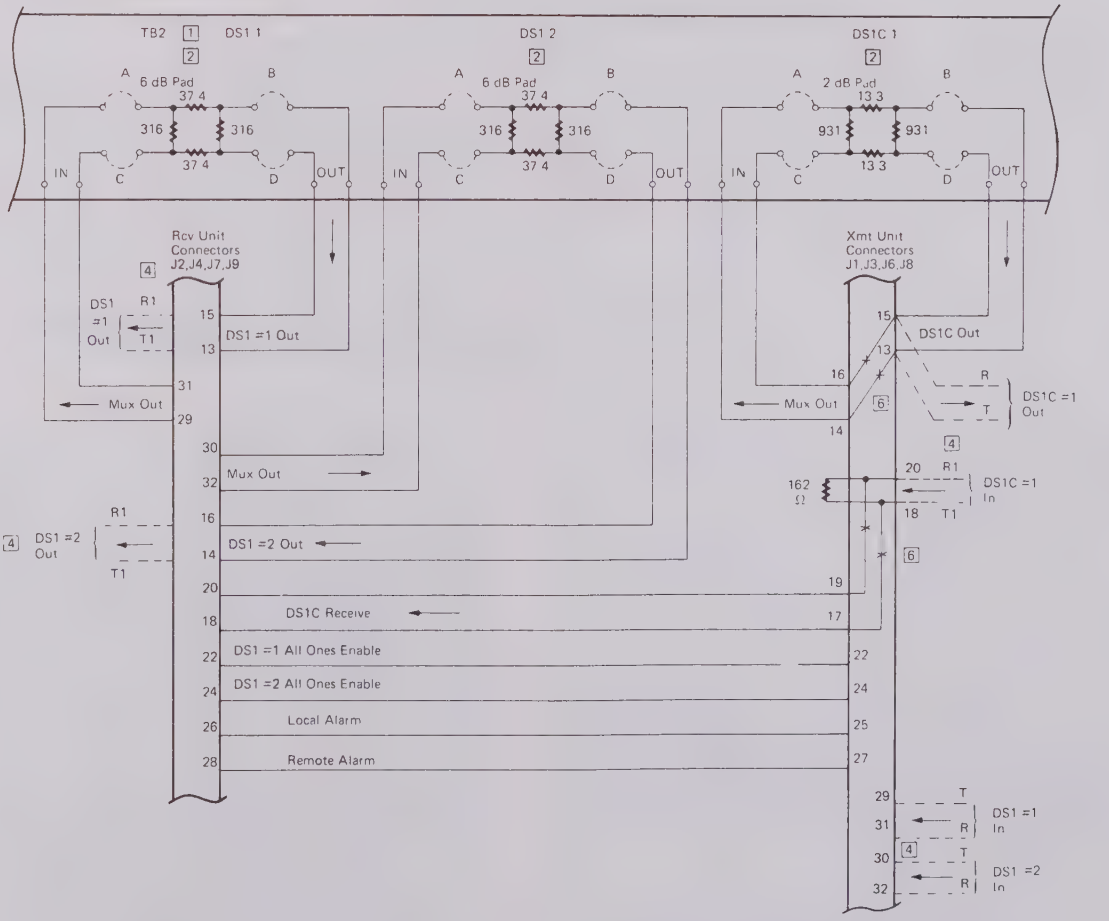

TB2
1
2
DS1 1
DS1 2
DS1C 1
A
B
C
D
6 dB Pad
2 dB Pad
37.4
316
931
13.3
IN
OUT
Rcv Unit Connectors J2,J4,J7,J9
Xmt Unit Connectors J1,J3,J6,J8
4
DS1 #1 Out
R1
T1
DS1 #1 Out
Mux Out
Mux Out
DS1 #2 Out
DS1 #2 Out
DS1C Receive
DS1 #1 All Ones Enable
DS1 #2 All Ones Enable
Local Alarm
Remote Alarm
DS1C Out
R
T
DS1C #1 Out
6
162 Ω
DS1C #1 In
DS1 #1 In
DS1 #2 In
13
14
15
16
17
18
19
20
22
24
25
26
27
28
29
30
31
32

Figure 7-1. 91481 Shelf Wiring Diagram (Sheet 2 of 2)

NOTES:

[1] Each muldem, consisting of one receive and one transmit unit, requires three pads or equalizers (two DS1 outputs and one DS1C output). The shelf makes provisions for four muldems, with TB2 providing 12 pads or equalizer mounting spaces. The figure shows connections for a single muldem. Identical connections are used for each additional muldem equipped on the shelf.

[2] Where an equalizer is required, disconnect the pad by cutting straps at A, B, C, and D on TB2. Place equalizer on four associated connector pins and solder. Refer to paragraphs 6.10 - 6.12 and to note 5.

3 For installation wiring, refer to paragraphs 6.13 - 6.19.

[4] Dashed lines indicate external connections.

[5] Equalizer Mounting Positions

Muldem No.	Equalizer Positions
1	DS1C-1, DS1-1, DS1-2
2	DS1C-2, DS1-3, DS1-4
3	DS1C-3, DS1-5, DS1-6
4	DS1C-4, DS1-7, DS1-8

Equalizers For DS1 Positions

Cable Length to DSX-1 In Metres (feet)		Codes For Ordering Equalizers (Stock No.)
GTS 8507	GTS 8510, or ABAM	
0-14 (0-46)	0-17 (0-55)	No equalizer required. Use DS1 6-dB pads on TB2
14-90 (46-294)	17-108 (55-355)	91481-01 Code CA equalizers (2 each). (087-56705-01)
90-166 (294-544)	108-200 (355-655)	91481-01 Code CB equalizers (2 each). (087-56705-02)

Equalizers for DS1C Position

Cable Length to DSX-1C In Metres (feet)		Codes for Ordering Equalizers (Stock No.)
GTS 8507	GTS 8510, or ABAM	
0-35 (0-115)	0-41 (0-133)	No equalizer required. Use DS1C 2-dB pad on TB2
35-70 (115-230)	41-81 (133-267)	91481-01 Code CD equalizer (1 each). (087-56705-03)
70-105 (230-344)	81-122 (267-400)	91481-01 Code CE equalizer (1 each). (087-56705-04)

[6] See Note 2, figure 3-2, for explanation of switching contacts.

[7] The audible and visual alarm leads are multipled (in parallel) to each 91481 shelf on the rack

Figure 7-2. Resistance Requirements at Shelf Input and Output Terminals

Figure A. Shelf Input Resistance Measurements

Circuit Measured	Shelf Terminals			Resistance (Ohms)
	Pins	Jacks	Status	
DSIC In	18, 20	J2, J4, J7, J9	Rcv Unit In	105
			Rcv Unit Out	162
DSI-1 In	29, 31	J1, J3, J6, J8	Xmt Unit In	95
			Xmt Unit Out	Open
DSI-2 In	30, 32	J1, J3, J6, J8	Xmt Unit In	95
			Xmt Unit Out	Open

Figure B. Shelf Output Resistance Measurements [1]

Circuit Measured	Shelf Terminals			Resistance (Ohms) [1]					
				2 dB	6 dB	087-56705-XX Equalizer			
	Pins	Jacks	Status	Pad	Pad	01	02	03	04
DSIC Out	13, 15	J1, J3, J6, J8	Xmt Unit In	26	NA	NA	NA	26	26
			Xmt Unit Out	7	NA	NA	NA	7	7
DSI-1 Out	13, 15	J2, J4, J7, J9	Rcv Unit In	NA	61	77	46	NA	NA
			Rcv Unit Out	NA	175	1147	265	NA	NA
DSI-2 Out	14, 16	J2, J4, J7, J9	Rcv Unit In	NA	61	77	46	NA	NA
			Rcv Unit Out	NA	175	1147	265	NA	NA

NOTES.

[1] Resistances are shown for a shelf equipped with an attenuator pad or one of four 087-56705 equalizers (-01 through -04). Values shown have a tolerance of ±10%

shelf accommodates up to four muldems, 12 pads and 12 equalizer spaces are provided (three pads and equalizer spaces for each muldem).

6.12 Where cable length requires the use of an equalizer, remove the pad from the circuit by cutting the four straps, A, B, C, and D. (See figure 7-1.) Place the equalizer on the four associated connector pins (A, B, C, and D) and solder the connections.

Cabling

6.13 For DS1 and DS1C signal transmission between the 9122A assemblies and cross-connect points, the use of type GTS-8507, GTS-8510, or WECo ABAM is recommended. GTS-8510 and WECo ABAM are multipair cables having unshielded 22-gauge pairs within a common shield. GTS-8507 is a high-frequency terminating cable with 1, 5, 8, 10 or 12 shielded pairs.

DS1 and DS1C Connections

6.14 Make signal input and output connections to pins at the rear of the equipment shelf connectors for the receive and transmit units. Connector and pin numbers for these connections are identified in figure 6-1.

Alarm Connections

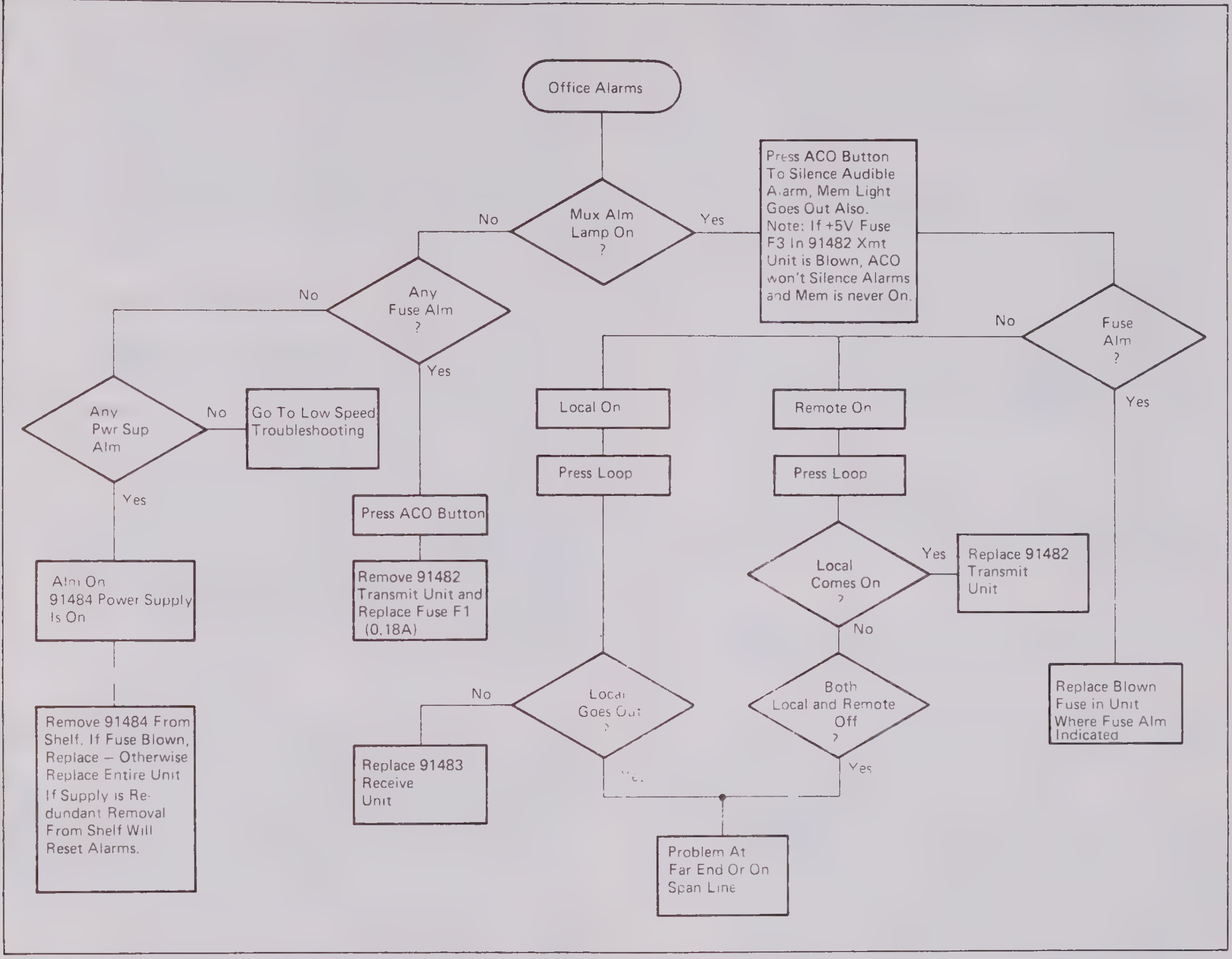
6.15 The recommended wire for office alarm connections is 22 AWG, minimum. Make the connections as follows and as illustrated in figure 6-3.

(a) Connect the AUD ALM terminal at the rear of the 91485 Alarm Panel to pin 21 on connector J10 (or J1) of each equipment shelf. Connect the VIS ALM terminal to pin 23 on connector J10 (or J1) of each equipment shelf.

NOTE: The AUD and VIS ALM leads are multipled (parallel connected to the 91481 Shelves).

(b) Make connections to office audible and visual alarms so as to obtain either a "normally-open" or a "normally-closed" circuit between the 91485 Alarm Panel and the office alarm equipment. For a normally-open audible alarm circuit, make connections at pins A1 and A2 on the alarm panel; for a normally open visual alarm circuit, make connections at pins A4 and A5. For normally-closed circuits, use pins A2 and A3 for audible alarm, and A5 and A6 for visual alarm.

Figure 7-3. Troubleshooting Flow Chart


Office Alarms
Mux Alm Lamp On ?
No
Yes
Press ACO Button To Silence Audible Alarm, Mem Light Goes Out Also. Note: If +5V Fuse F3 In 91482 Xmt Unit is Blown, ACO won't Silence Alarms and Mem is never On.
Any Fuse Alm ?
No
Yes
Fuse Alm ?
No
Yes
Any Pwr Sup Alm
No
Yes
Go To Low Speed Troubleshooting
Local On
Press Loop
Remote On
Press Loop
Press ACO Button
Remove 91482 Transmit Unit and Replace Fuse F1 (0.18A)
Alm On 91484 Power Supply Is On
Local Comes On ?
Yes
No
Replace 91482 Transmit Unit
Remove 91484 From Shelf. If Fuse Blown, Replace – Otherwise Replace Entire Unit If Supply is Redundant Removal From Shelf Will Reset Alarms.
Local Goes Out ?
No
Yes
Replace 91483 Receive Unit
Both Local and Remote Off ?
Yes
Replace Blown Fuse in Unit Where Fuse Alm Indicated
Problem At Far End Or On Span Line

NOTE: Unplug the relay assembly from the 91485 Alarm Panel to prevent a continuous office alarm prior to the application of power.

Power Connections

6.16 Do not install fuses in the 91155 Fuse and Alarm Shelf until all of the following power wiring has been completed.

6.17 Power Source to Distribution. This wiring is from the power source (office batteries) to the 91155 Fuse and Alarm Shelf. It is recommended that the wiring be rated for five amperes for each 91481 shelf to be powered. Figure 6-2 shows fuse module requirements, bus bars, and power source connections for assemblies having seven or less muldem shelves and assemblies having more than seven muldem shelves, with redundant and non-redundant power supplies.

6.18 Power to Alarm Panel. The recommended wire for this connection is 20 AWG (0.80 mm) minimum. Make the —48V connections as shown in figure 6-2 and figure 6-3. Note that this connection is only from the first fuse module (A2) on the 91155 shelf.

6.19 Power to Muldem Shelves. The recommended wire for these connections is 18 AWG (1.00 mm) minimum, for a nominal current of 2.1 amperes in each fully-equipped shelf. Refer to the appropriate assembly in figure 6-2, and to figure 6-3 for power and ground connections to be made at TB1 on each muldem shelf. Note that while requiring only one office power feed, non-redundant power supplies require two shelf feeds from separate fuse modules.

Fuse Installation

6.20 When the above wiring has been completed, and prior to installing plug-in units in the equipment shelves, install fuses in the 91155 Fuse and Alarm Panel. Refer to figure 7-4.

Preliminary Test

6.21 When installation has been completed, it is desirable to put the equipment through a trial run. A procedure for out-of-service testing follows. (Refer to Technical Summary for description of controls, indicators, and test points).

6.22 With plug-in units installed in the shelves and span lines connected and operating properly, all alarm lights should be out. The MEM LED may be extinguished by pressing the ACO switch.

6.23 At the near-end multiplexer, unplug the receive unit (of one system) from the shelf. This should have the following results:

Figure 7-4. Fuse Locations, Types, Quantities, and Alarms

Location, Type, and Stock No.	Function and Quantity Used	If Fuse Blows: Alarm Indications and Action
91155 Shelf, 5A GMT, 175-28996-10	—48V power to 91481 Muldem Shelves. One per shelf.	Office alarms through alarm relay on NEG ALM on 91155 shelf. Remove fuse to silence audible alarm. If replacement fuse blows, check wiring for unwanted ground.
91155 Shelf .18A GMT 175-28996-04	—48V power to 91485 Shelf. One per rack.	Office alarms through alarm relays on 91155 and 91485 shelves. NEG ALM on 91155 shelf. Replace fuse. If replacement fuse blows, check wiring for unwanted ground.
91482 Xmt Unit (F1) .18A GMT 175-28996-04	—48V circuits in unit. One per unit.	FUSE ALM on unit; office alarms. Press ACO button to silence audible alarm. If replacement fuse blows, replace xmt unit.
91482 Xmt Unit (F2) .18A GMT 175-28996-04	—15V circuits in unit. One per unit.	FUSE ALM on unit; REMOTE alarm; office alarms. Press ACO button to silence audible alarm. If replacement fuse blows, replace xmt unit.
91482 Xmt Unit (F3) 1.3A GMT 175-28996-02	+8V circuits in unit. One per unit.	FUSE ALM on unit; REMOTE, MUX and office alarms. Unplug xmt unit to silence audible alarm. If replacement fuse blows, replace xmt unit.
91483 Rcv Unit (F1) .18A GMT 175-28996-04	—15V circuits in unit. One per unit.	FUSE ALM on unit; MUX alarm, office alarms. Press ACO button to silence audible alarm. If replacement fuse blows, replace rcv unit.
91483 Rcv Unit (F2) 1.3A GMT 175-28996-02	+8V circuits in unit. One per unit.	FUSE ALM on unit; MUX alarm, office alarms. Press ACO button to silence audible alarm. If replacement fuse blows, replace rcv unit.
91484 Power Supply 3A GMT 175-28996-07	—48V input to unit. One per unit.	ALM on unit; office alarms. MUX alm if supply is non-redundant. In redundant supplies, MUX alarm is prevented as one PS unit immediately takes full load if other unit fails. Unplug PS unit to deactivate office alarms. If replacement fuse blows, replace PS unit.

(a) At the near end:

  (1) The MUX ALM lamp and the MEM lamp on the transmit unit of the system will light, and office alarms will operate.

  (2) Push the ACO button. The office audible alarm will be silenced and the MEM lamp will extinguish.

(b) At the far end:

  (1) The REMOTE alarm lamp on the receive unit will light. The MUX ALM lamp and the MEM lamp on the transmit unit will light. Office alarms will operate.

  (2) Press the ACO button. The audible alarm will be silenced and the MEM lamp extinguished.

  (3) Press the LOOP button on the transmit unit. The LOOP lamp will light, indicating that the loop circuit is operating. The REMOTE alarm lamp will extinguish.

  (4) Insert a test signal at the DS1 jacks (Nos. 1 and 2) on the transmit unit, and test the signals at the DS1 OUT MON jacks (Nos. 1 and 2) on the receive unit. (Refer to figure 5-6 for recommended test equipment.)

  (5) Press LOOP button to deactivate loop circuit. LOOP lamp will extinguish.

6.24 At the near end, restore the receive unit to the shelf.

6.25 At the far end, unplug the receive unit from the shelf and perform the preceding tests in the opposite direction of transmission. Upon completion of the tests, restore the receive unit to the shelf.

6.26 At the near-end multiplexer, remove the transmit unit of the system from the shelf and check for the following results at the far end:

(a) The LOC alarm lamp on the receive unit will light The MEM and MUX ALM lamps on the transmit unit will light. The office alarms will operate.

(b) Press the ACO button. The office audible alarm will silence, and the MEM lamp will extinguish.

6.27 At the near end, restore the transmit unit to the shelf. At the far end, remove the transmit unit from the shelf. The events described in paragraph 6.26 should now occur at the near end.

7. MAINTENANCE

7.01 The 9122A Multiplexer has no requirements for regularly-scheduled maintenance. Operation of the system is continuously monitored by failure-detection and alarm circuits. That these circuits are functioning normally can be tested by observing the response of alarm indicators to a forced alarm condition (paragraphs 6.21 through 6.27).

System Performance Tests

7.02 Test Equipment. The Digital Carrier Analysis Test Set listed in figure 5-6 generates a continuous DS1 test signal with a repetitive quasi-random (QRSS) pattern of 1,048,575 bits. With one test set transmitting and another receiving, end-to-end system performance is measured by counting pattern errors over a predetermined interval. Terminal performance can be measured with one test set, in a loopback arrangement, performing the transmit and receive functions.

7.03 Adjust the test set as follows (refer to the manufacturer's instruction manual for specific contro settings):

(a) Adjust the test set generator controls for an error-free DS1 output signal. (Patch transmit section of test set to receive section of test set for this "self" test.)

(b) Adjust the test set receiver controls for a count of total logic errors (pattern errors, not bipolar violations).

(c) A test cycle consists of a count interval followed by a display interval. Set the test set controls for continuous test cycles with automatic reset, for any convenient display interval, and a bit counting interval appropriate to the maximum allowable error rate.

(d) Remove all patch cords.

7.04 End-to-End Test. The end-to-end test can be performed on one DS1 signal at a time (No. 1 or No. 2) without disrupting the other DS1 signal. The procedure follows:

(a) Adjust the test set as described (paragraph 7.03).

(b) At the transmit end of the system under test, connect the test set or equivalent QRSS generator to the DS1 IN jack (No. 1 or No. 2) on the transmit unit. At the receive end of the system, connect the test set receiver to the corresponding MON jack on the receive unit.

(c) At the receive end, monitor the error display through several cycles. The maximum allowable error rate is 1 in 10^7.

7.05 Loopback Test. Unlike the end-to-end test described above, the loopback method of testing requires service disruption on both channels. The loopback circuits can be activated only when the MUX ALM and ACO lamps are on as the result of a failure. (See paragraphs 3.34-3.36.) The failure may be simulated as in paragraphs 6.25 and 6.27. The procedure follows:

(a) Adjust the test set as described (paragraph 7.03).

(b) With the MUX ALM lamp on, press first the ACO button and then the LOOP button. Both indicators should light.

(c) Connect the test set QRSS generator to the DS1 jack (No. 1 or No. 2) on the transmit unit. Connect the test set receiver to the corresponding DS1 MON jack on the receive unit.

NOTE: Channel banks which were receiving an all-ones pattern are now receiving a QRSS pattern. Both patterns will maintain an alarm condition in the channel bank.

(d) Monitor the error display through several test cycles. The maximum allowable error rate is 1 in 10^8.

Troubleshooting

7.06 Factory Wiring. Figure 7-1 is a diagram of factory-installed shelf wiring.

7.07 Use of MEM Indicator. Should a MUX alarm occur, the MEM lamp will light and remain lighted until the ACO button is pressed by the operator. In the event of intermittent and transient alarms, this identifies the system.

7.08 Voltage Checks. All voltages can be checked at jacks on the front panel of the power supply unit. Requirements are —48V (—44 to —56), —15V (—15 to —20), and +8V (+8 to +11).

7.09 Resistance Checks. Figure 7-2 lists resistance values which should be present across the DS1 and DS1C input and output terminals of the 91481 shelf. Two values are given: one with the transmit or receive unit installed in the shelf connector, and one with the unit removed from the connector. Measurements to check for correct resistance can be made directly at the shelf terminals, as in figure 7-2, or at a point external to the shelf, such as a DSX panel.

7.10 Troubleshooting. Figure 7-3 charts a systematic course of action for tracing an office alarm to its source.

CAUTION: Do not loop an in-service multiplexer (whether in alarm or not) at the span line terminating equipment or the DSX-1C jacks. Such a loop would cause tributary channel banks to restore because they would be looped on themselves. Use the multiplexer looping button, thereby transmitting an all-ones pattern which will hold the channel banks in alarm.

7.11 Generally, a local alarm at a terminal (call it terminal A) will be accompanied by a remote alarm at the opposite terminal of the system (call it terminal B). Troubleshooting this type of alarm indication is outlined below.

7.12 Alarm Indications. LOCAL alarm and MUX ALM at terminal A. REMOTE alarm and MUX ALM at terminal B. Proceed as follows:

(a) At both terminals, press the ACO button. At both terminals, the ACO lamp will light, and the audible alarm will silence.

(b) At terminals A and B, press the LOOP button. This will activate the loopback function at both terminals. Check for one of the following indications:

(1) LOCAL alarms extinguish at terminal A; REMOTE alarms extinguish at terminal B. This indicates that the 9122A multiplexer equipment is operating properly at both terminals. The trouble is probably in the span line, in the B-towards-A direction of transmission. Check for an indication at the terminal A line-terminating shelf.

(2) LOCAL alarm lamps extinguish at terminal A. At terminal B, the REMOTE alarm lamp extinguishes and the LOCAL alarm lights. The indication is a defective transmit unit at terminal B. Try a replacement transmit unit.

(3) REMOTE alarm lamps extinguish at terminal B. At terminal A, the LOCAL alarm and MUX alarm lamps remain lighted. The indication is a defective receive unit at terminal A. Try a replacement receive unit.

Fuse and Power Alarms

7.13 In redundant power supplies, the failure of one 91484 unit will not disrupt service since the other unit will immediately take the full load. An ALM light on the failed unit is indicative of a blown fuse or a drop to alarm threshold in a voltage level. Levels can be checked at test jacks on the unit. Fuse locations, types, quantities, alarm indications, and corrective actions are listed in figure 7-4.

NOTE: The 9122A is unresponsive to errors in the low-speed signaling and will not alarm for this type of failure, even should it occur in the multiplexer; however, channel banks or other equipment interfacing the low-speed side will alarm.

Factory Repair Service

7.14 Field repair of defective units is not recommended. Equipment failures should be corrected by replacing the defective unit with a spare. Defective units should be tagged with the defect identified where possible, and sent to GTE Lenkurt, San Carlos, attention: Factory Service Department, where most items can be repaired within 14 to 20 calendar days after equipment is received at the factory. If spares are not available and down time is critical, this service can be accelerated or temporary replacement units can be furnished while the defective unit is being repaired (GTE Lenkurt's CARE Program: Customer Accommodation Restoration Equipment). In any such emergency, contact a GTE Lenkurt Factory Service Representative: (415) 595-3000 (day or night). For equipment out of warranty, there is a charge only for the repair and test of the defective unit. If a temporary CARE unit is required, there is an additional handling charge. Information on defective units may be furnished informally eithe by mail or telephone but should include a Purchase Orde number as well as ship-to and bill-to addresses. Details on GTE Lenkurt's Factory Repair and CARE services may be obtained from any GTE Lenkurt Sales Representative. For further information, GTE companies may refer to GTE Practice Section 992-600-003, "Repair and Return, GTE Lenkurt Equipment." Other GTE Lenkurt customers may obtain copies of the brochure "Factory Repair Service" (0-2631) from any GTE Lenkurt Sales Office.

GTE LENKURT

Company Headquarters and
Manufacturing Facility

1105 County Road
San Carlos, California 94070
Phone 415—595-3000

Albuquerque
Manufacturing Facility

One Camino de Lenkurt
Albuquerque, New Mexico 87123
Phone 505—296-0551

El Paso
Manufacturing Facility

10727 Gateway West
El Paso, Texas 79935
Phone 915—593-3400

District
Sales Offices

1105 County Road
San Carlos, California 94070
Phone 415—595-3000

120 West Eastman Street
Arlington Heights, Illinois 60004
Phone 312—398-6700

542 Haggard Street, Suite 510
Plano, Texas 75074
Phone 214—422-4306

7950 Woodruff Court
Springfield, Virginia 22151
Phone 703—321-8560

5780 Peachtree-Dunwoody Road, N.E.
Suite 145
Atlanta, Georgia 30342
Phone 404—256-3000

GTE International
Sales Office

1105 County Road
San Carlos, California 94070
Phone 415—595-3000
Cable: GENTELINT

91254 Four-Wire E&M Channel Unit

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1. GENERAL

1.01 This Section describes the 91254 Four-Wire E&M Channel Unit and covers applications, functional operation, installation, and maintenance. Block-schematic diagrams are included.

1.02 The channel unit is a plug-in module of the 9002A PCM Channel Bank (Section 342-911-103) and the 9002B PCM Channel Bank (Section 342-911-107). Refer to Section 342-911-108 for basic information about 9002A/B channel units.

1.03 This Section is reissued to include coverage of the 91254-04 option of the model 2 91254 channel units. The -04 option gives the model 2 the capability to transmit a forced busy condition (paragraph 3.17). Other minor editorial changes are made. Changed areas are indicated by marginal arrows.

1.04 The equipment covered in this publication is the latest model as of the publication date. Later models are capable of greater application or are more effective in the performance of their functions than earlier models. A later model supersedes an earlier model of the same type number and may always be substituted for the earlier model.

2. APPLICATIONS

2.01 Functional capabilities of each of the various units are summarized in figure 1; drop and alignment levels are given in figure 2. All of the units provide intertoll grade vf transmission and E&M signaling. Impedance is 600 ohms at the four-wire vf transmit and receive ports.

91254 Model 2 Channel Unit

2.02 As a general-purpose nontandem channel unit, the 91254 model 2 channel unit can be used anywhere that the 91240-01 or -02 channel unit has been previously acceptable. It does not have normal-through vf jacks facing the carrier and drop. If required, this feature can be provided on external jackfields that are more suited to restoral patching.

2.03 Signaling. By means of strapping plugs, the 91254-02, -03, or -04 channel unit can be arranged as a "standard E&M unit" or as a tandem "back-to-back unit." The on-hook/off-hook conditions for the standard E&M unit are as follows:

(a) Type I or III interface: open/ground on the E lead and ground/battery on the M lead.

(b) Type II interface: open/closed on the E lead and open/battery on the M lead.

2.04 At a trunk circuit interface, the 91254-02, -03 or -04 unit is strapped as a standard E&M unit. The interface may be type I, II, or III. At a tandem point, the channel unit is strapped accordingly and connected back-to-back with the E&M channel unit of another fdm or pcm carrier system. As shown in figure 3, the interface is type I, and the on-hook/off-hook conditions of the back-to-back unit are ground/battery on the E-lead output and open/ground on the M-lead input.

NOTE: The 91254 cannot be used for back-to-back connection of foreign-exchange or 910A subscriber channels at a tandem point. These applications require the 91257 Four-Wire Tandem Channel Unit, which has two sets of E&M leads (for the A and B signaling channels).

2.05 VF Levels. The 91254-02, -03, and -04 channel units have 6.3-dB transmit and receive attenuators, strappable in 0.1-dB steps, to compensate for office wiring and apparatus loss (OL) and to build out via net loss (VNL). Attenuator settings are determined by one of the following formulas.

(a) Standard E&M unit:

Transmit = 1.5 — OL
Receive = 1.5 — OL

(b) Back-to-back unit not at a digital switch:

Transmit = 2.5 — OL
Receive = 1.5 — OL

(c) Back-to-back unit at a digital switch:

Transmit (TP0 at far end) = 2.5 — OL
Transmit (TP2 at far end) = 1.5 — OL + VNL
Transmit (TP3 at far end) = 2.5 — OL + VNL
Receive = 1.5 — OL

NOTE: The attenuator range is insufficient for the 91254 to serve as a maintenance access channel unit for the No. 3 EAX digital switch.

Figure 1. Functional Capabilities of the 91254 Units

Function	Model 1	Model 2			
	-01	-01	-02	-03	-04
10-second delay TMB	Yes	Yes	Yes	Yes	Yes
BUSY switch, with LED indicator, to open M-lead to drop, busy E-lead, and open vf drops	No	Yes	Yes	Yes	Yes
Optional E- and SG-lead on-hook, off-hook, or delayed off-hook during system alarm	Yes	Yes	Yes	Yes	Yes
4-wire receive monitor test points	Yes	Yes	Yes	Yes	Yes
C, OS, or B1-B2 leads	OS or B1-B2	All	None	All	All
Enables tandem applications	No	No	Yes	Yes	Yes
4-wire alignment jacks	Yes	Yes	Yes	Yes	Yes
Attenuators for office wiring and trunk loss	No	No	Yes	Yes	Yes
Back-to-back capability	No	No	Yes	Yes	Yes
Types I, II and III E&M signaling	Type I	Type I	All	All	All
Strap-selectable E-lead signaling options	No	No	Yes	Yes	Yes
BUSY switch option (strap-selectable) to transmit a forced busy condition	No	No	No	No	Yes

Figure 2. Drop and Alignment Levels

Channel Unit		Transmit/Receive Drop Levels, dBm	Alignment Jacks and Levels
Model	91254-		
1	-01	—16/+7	Normal-thru toward drop and carrier; —16.7/+7.7 dBm (requires 91256 Test Level Adapter)
2	-01	—16/+7	Pin jack test points; —16/+7 dBm
2	-02 -03 -04	Non-tandem Xmt: —11.2 to —17.5 Rcv: +8.5 to +2.2 Tandem Xmt: +5.5 to +10.8 Rcv: —14.5 to —20.8	Normal-thru toward carrier; —16/+7 dBm

2.06 Nominal transmit/receive levels at the vf ports are —16/+7 dBm for the standard E&M unit and +7/—16 dBm for the back-to-back unit. In a back-to-back arrangement as shown in figure 3, a crosstalk advantage may be obtained by strapping for +7 dBm in each direction, subject to the following conditions:

(a) The tandem fdm or pcm channel unit will accept the +7 dBm transmit level.

(b) External —16 dB TLP's are not required.

(c) Crosstalk problems are not created in other lower-level transmit pairs in the same cable run.

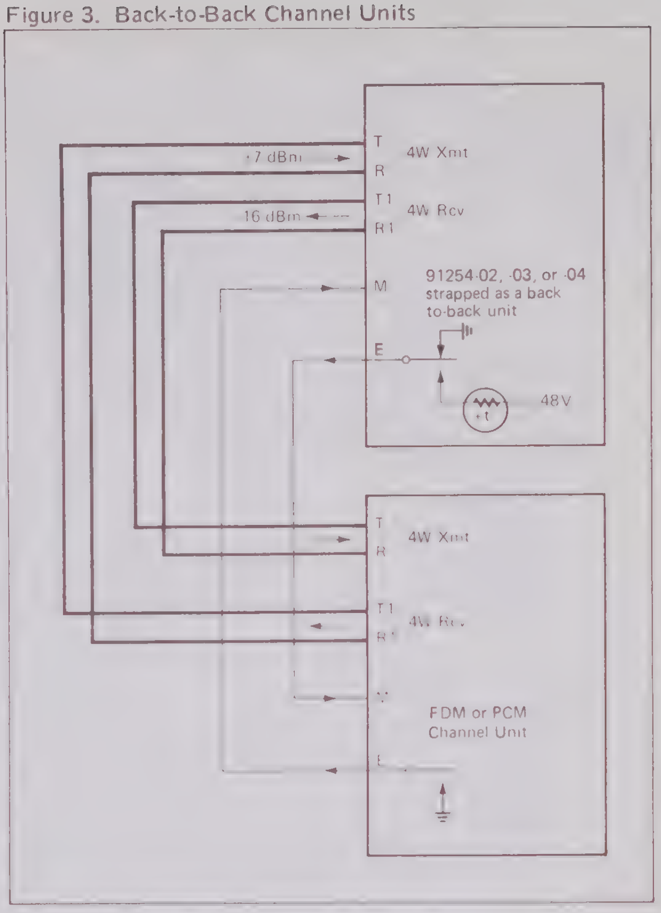
3. FUNCTIONAL CIRCUIT OPERATION

3.01 Refer to Section 342-911-108 for an explanation of the basic vf and signaling circuits of the channel unit and the common equipment interface.

91254-01 Model 1 (figure 4)

3.02 VF Transmission. Transmit/receive levels at the four-wire vf ports are —16/+7 dBm. Because of the insertion loss of balancing transformers T1 and T2, the 4W XMT and 4W RCV jacks are —16.7 dB and +7.7 dB transmission level points (TLP), respectively.

Figure 3. Back-to-Back Channel Units



3.03 E&M Signaling. Ground on the M lead (on-hook) produces logic 1 at the input to transmit signaling circuits A and B. With —48V battery on the M lead (off-hook), the zener diode conducts, changing the transmit signaling state to logic 0. In the receive direction, an off-hook condition on RCS operates relay K1 and contacts K1-1 ground the E lead.

3.04 System Alarm. In a channel bank system alarm, the TMB' lead is grounded by release of a relay in the 91230 alarm unit. Relay K2 operates and contacts K2-1 busy the trunk by grounding the OS (out-of-service) lead or closing B1 to B2, as selected by strapping. Ground on TMB' also presets a flip-flop in the receive signaling circuit, imposing an on-hook condition on the E lead by releasing relay K1 if it is operated.

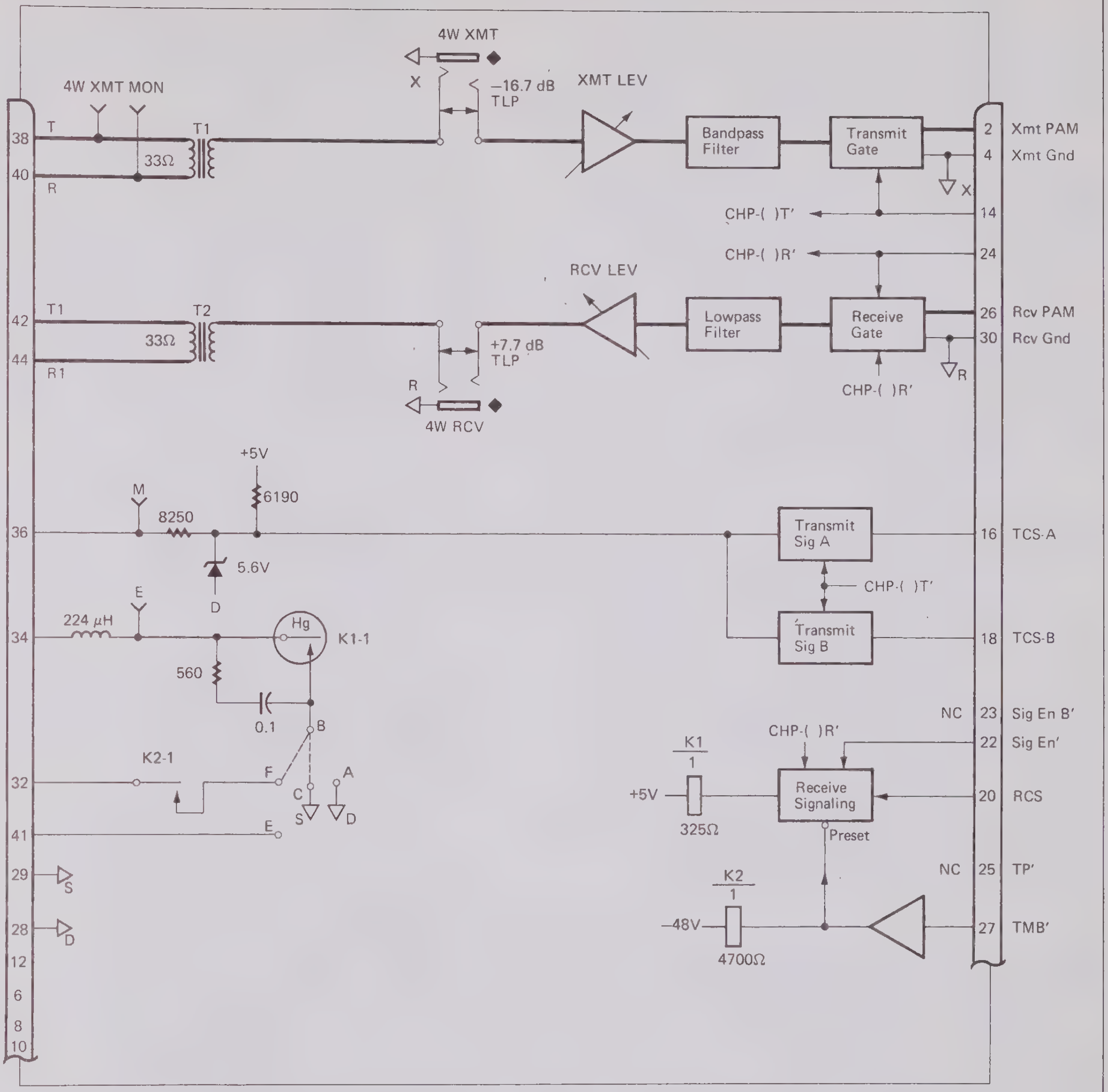
91254-01 Model 2 (figure 5)

NOTE: The -01 channel unit is a stripped-down version of the -03 channel unit, which appears in figure 6.

3.05 VF Transmission. The four-wire vf ports are fixed transmission level points, —16 dB transmit and +7 dB receive. For channel unit alignment, the external vf drop equipment is disconnected by depressing the NORM/BUSY pushbutton, and the 91232 test set is connected to pin-jack test points 4W XMT MON and 4W RCV MON.

3.06 E&M Signaling. The input to transmit signaling circuits A and B is biased to logic 1 by +12V through a 31.6-kΩ resistor. Open or ground (on-hook) on the M lead maintains the logic 1, but —48V battery (off-hook) changes the input to logic 0. In the receive direction, logic 0 (off-hook) from the receive signaling circuit operates the E relay and the E-1 contacts ground the normally open E lead.

Figure 4. 91254-01 Model 1 Channel Unit, Circuit Diagram


4W XMT
X
–16.7 dB TLP
XMT LEV
4W XMT MON
T
T1
4W Xmt Z=600Ω
38
40
33Ω
R
Bandpass Filter
Transmit Gate
2 Xmt PAM
4 Xmt Gnd
X
CHP-( )T'
14
CHP-( )R'
24
RCV LEV
4W Rcv Z=600Ω
42
44
T1
T2
33Ω
R1
Lowpass Filter
Receive Gate
26 Rcv PAM
30 Rcv Gnd
R
+7.7 dB TLP
R
4W RCV
CHP-( )R'
+5V
M
6190
8250
M 36
5.6V
D
E
224 μH
E 34
Hg
K1-1
560
0.1
B
Transmit Sig A
16 TCS-A
CHP-( )T'
Transmit Sig B
18 TCS-B
NC 23 Sig En B'
22 Sig En'
CHP-( )R'
K1 1
K2-1
OS or B1 32
F
A
C
S
D
B2 41
E
+5V
325Ω
Receive Signaling
20 RCS
Preset
Signal Gnd 29
S
Digital Gnd 28
D
+5V 12
+12V 6
–12V 8
–48V 10
K2 1
NC 25 TP'
–48V
4700Ω
27 TMB'

NOTES:

1. Strapping Options

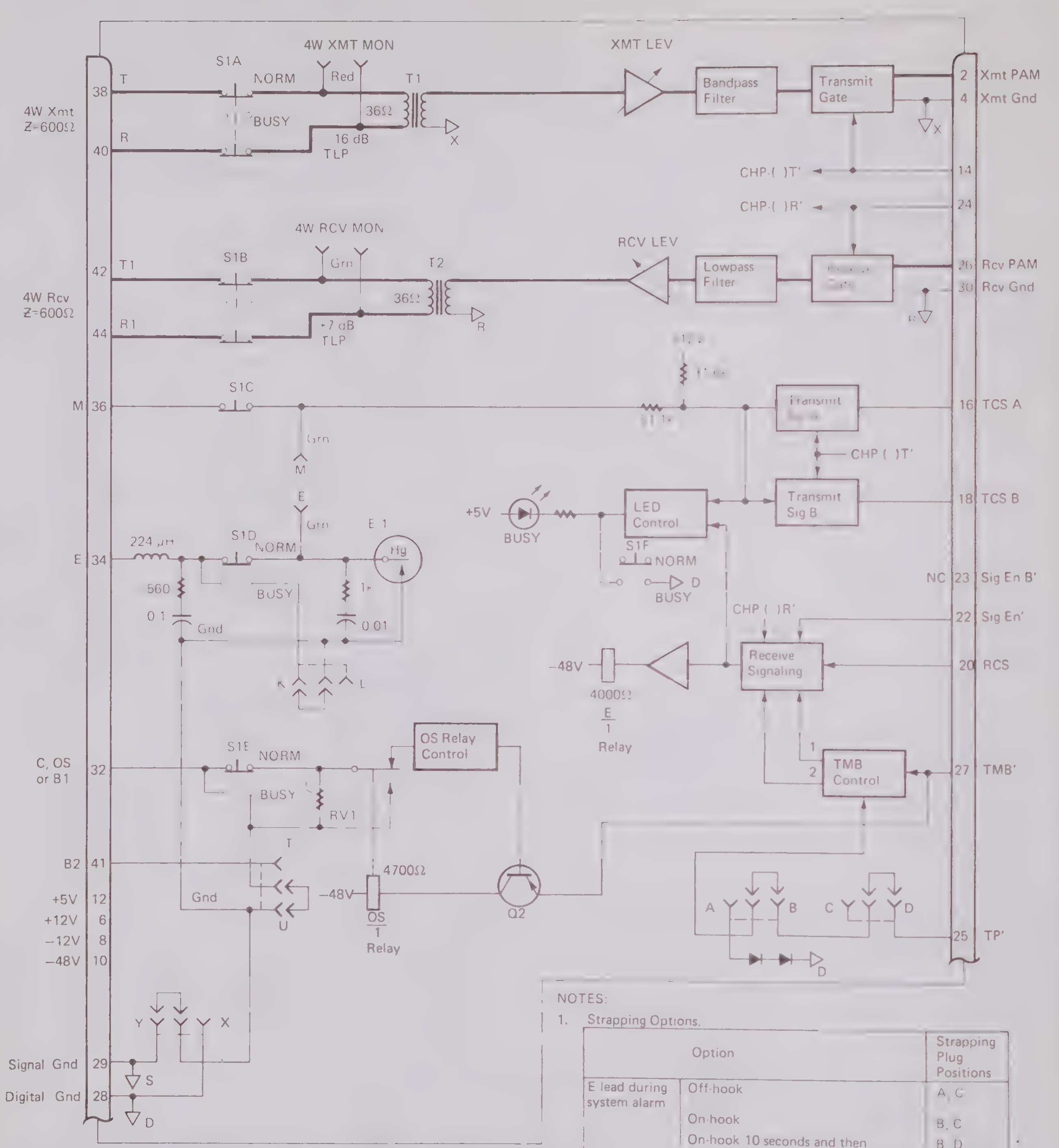
Option		Strap	
Alarm leads	OS	B-F	*
	B1 and B2	E-F	
Equipment shelf	91220-M1, -M2, and -M3 Issue 1	A-B	
	91220-M3 Issue 2 and 91330	B-C	*

*Factory strapping

2. E&M Signaling Leads. On-hook/off-hook signaling conditions are open/ground on the E lead and ground/battery on the M lead.

3. Resistors and Capacitors. Unless otherwise specified, values are in ohms and microfarads.

Figure 5. 91254-01 Model 2 Channel Unit, Circuit Diagram


4W XMT MON
XMT LEV
S1A
NORM
BUSY
Red
T1
36Ω
16 dB TLP
X
Bandpass Filter
Transmit Gate
2 Xmt PAM
4 Xmt Gnd
CHP-( )T'
14
CHP-( )R'
24
4W Xmt Z=600Ω
T
38
R
40
4W RCV MON
RCV LEV
S1B
Grn
T2
36Ω
+7 dB TLP
R
Lowpass Filter
26 Rcv PAM
30 Rcv Gnd
4W Rcv Z=600Ω
T1
42
R1
44
M 36
S1C
Grn
M
E
16 TCS A
CHP ( )T'
Transmit Sig B
18 TCS B
+5V
BUSY
LED Control
S1F
NORM
D
BUSY
E 34
224 μH
560
0.1
Gnd
S1D
NORM
BUSY
E 1
Hg
0.01
K
L
NC 23 Sig En B'
22 Sig En'
CHP ( )R'
–48V
4000Ω
E 1 Relay
Receive Signaling
20 RCS
C, OS or B1
32
S1E
NORM
BUSY
RV1
OS Relay Control
1
2
TMB Control
27 TMB'
B2 41
+5V 12
+12V 6
–12V 8
–48V 10
Gnd
T
U
–48V
4700Ω
OS 1 Relay
Q2
A
B
C
D
25 TP'
Y
X
Signal Gnd 29
S
Digital Gnd 28
D

NOTES:

1. Strapping Options.

Option		Strapping Plug Positions
E lead during system alarm	Off-hook	A, C
	On-hook	B, C
	On-hook 10 seconds and then off-hook	B, D *
E lead with S1 in BUSY position	Off-hook	K *
	On-hook	L
Alarm/busy lead	B1-B2	T
	C or OS	U *
Shelf	91220-M1, -M2, and -M3 Issue 1	X
	91220-M3 Issue 2 or 3; 91330	Y *

*Factory strapping

2. Strapping Plugs. The channel unit is equipped with five single-pole strapping plugs, pn 141-56699-01.

3. Resistors and Capacitors. Unless otherwise specified, values are in ohms and microfarads.

4. E&M Signaling Leads. On-hook/off-hook signaling conditions are open/ground on the E lead and ground/battery on the M lead.

3.07 System Alarm. In a channel bank system alarm, the TMB' lead is closed to ground by release of a relay in the 91230 alarm unit. The TMB control circuit in the channel unit preempts control of the E lead according to the option selected by strapping plugs A/B and C/D. The receive signaling state during a system alarm and the strapping plug positions for the three options are as follows:

(a) Off-hook (positions A and C): output 2 of the TMB control circuit latches the receive signaling circuit in the off-hook state to operate the E relay.

(b) On-hook (positions B and C): output 1 of the TMB control circuit presets the receive signaling circuit to the on-hook state. If operated, the E relay releases.

(c) Delayed off-hook (positions B and D): first, the receive signaling circuit is preset to the on-hook state. After 10 seconds, a single 40-ms pulse on the TP' lead activates output 2 of the TMB control circuit and the E relay operates.

3.08 Alarm/Busy Leads. The alarm or busy function of the channel unit is selected by the T/U strapping plug. Position T provides B1 and B2 leads at pins 32 and 41, and position U provides a C or OS lead at pin 32. With the NORM/BUSY pushbutton in NORM position, pin 32 is controlled in the following manner when a system alarm occurs.

(a) If pin 32 is a C lead and the trunk is idle, or if pin 32 is an OS or B1 lead, the lead is ungrounded externally and the OS relay control circuit is applying negative bias to the base of transistor Q2. When TMB' is grounded by the system alarm, Q2 turns on and operates the OS relay, which grounds pin 32 (C or OS) or closes pins 32 and 41 (B1 and B2).

(b) If pin 32 is a C lead and the trunk is busy, the C lead is grounded by the external switching equipment, and the OS relay control circuit outputs positive bias to the base of Q2. When TMB' is grounded by the system alarm, the OS relay does not operate. If the switching equipment ungrounds the C lead, the control circuit output changes to negative bias after a 50-millisecond delay. Transistor Q2 operates the OS relay, grounding the C lead until the system alarm ends.

3.09 Depressing the NORM/BUSY pushbutton to BUSY position grounds the external C or OS lead or closes B1 and B2.

91254-02, -03 and -04 Model 2 (figure 6)

3.10 VF Transmission. Vf signals enter the four-wire transmit port of the channel unit at the balanced input of transformer T1. The loss in the transformer (0.6 dB) and transmit attenuator (set at 1.5 dB) is offset by the gain of a 2.1-dB amplifier so that a —16 dBm input gives the required —16 dBm level at the 4W XMT CARR jack.

3.11 The loss and gain elements in the receive branch are the same as in the transmit branch. A +7 dBm level at the 4W RCV CARR jack gives the required +7 dBm at the four-wire vf receive port.

3.12 In a back-to-back (tandem) application, for transmit/receive levels of +7/—16 dBm, the unit is strapped to add a 22-dB pad to the transmit branch and a 23-dB pad to the receive branch. The reason for having a 22-dB transmit pad (instead of 23-dB) is to provide correct level coordination at a No. 3 EAX or No. 4 ESS digital switch when the remote end is terminated at a TP2 office. For other applications, the 1-dB difference can be made up in the transmit attenuator.

3.13 E&M Signaling. The channel unit can be strapped for a type I, II, or III E&M signaling interface. The type of interface and the applicable on-hook and off-hook conditions depend on whether the unit is to operate in the standard E&M or the back-to-back configuration. The strapping options are tabulated on figure 6.

3.14 Battery current to the SB lead or the E lead is limited by RT1, a positive temperature coefficient thermistor. The resistance of RT1 is less than 50 ohms ordinarily, but in a fault condition, if current exceeds about 100 mA, resistance increases to over 2,000 ohms and current decreases to about 25 mA.

3.15 According to the position of the strapping plug (E/F in the -02 and -03 options, AA/BB in the -04), and for a type I or III interface, the M lead is biased to respond to on-hook/off-hook conditions of open/ground (position E in -02 and -03, AA in -04), or ground/battery (position F in -02 and -03, BB in -04). For a type II interface, with the strapping plug in position E (-02 and -03) or AA (-04), the M-lead responds to open/battery.

3.16 The E relay operates when the channel unit receives off-hook signals on RCS. Four optional configurations of the E relay contacts are illustrated in the table of strapping options on figure 6.

3.17 Depressing the NORM/BUSY switch to the BUSY position produces the following effects:

(a) On the -02 and -03 Options. Placed in the BUSY position, the switch forces the E-lead to on-hook or off-hook, as selected by the K/L strapping plug. It opens the M-lead, thereby forcing an idle (on-hook) condition on the transmit signaling regardless of any strap position. As a consequence, these options cannot transmit a forced busy condition to the far terminal. With the switch in this position, signaling toward the carrier can be tested by patching a GTE Lenkurt 26600 Signaling Test Set to the E and M pin jacks.

(b) On the -04 Option. The BUSY functions of the switch are as described above for the -02 and -03, but with the added capability to transmit a forced busy condition by selecting the required CC-DD strap (see note 1, figure 6).

3.18 The BUSY indicator lights when the M lead is off-hook or the E relay is operated. It also lights steady when the NORM/BUSY pushbutton is in BUSY position; consequently, it does not flash during the pulsing test described in the preceding paragraph.

3.19 System Alarm. In a channel bank system alarm, the TMB' lead is closed to ground by release of a relay in the 91230 alarm unit. The TMB control circuit in the channel unit preempts control of the E lead according to the option selected by strapping plugs A/B and C/D. The receive signaling state during a system alarm and the strapping plug positions for the three options are as follows:

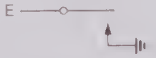
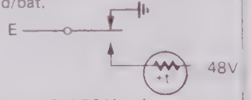
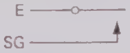
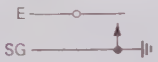
(a) Off-hook (positions A and C): output 2 of the TMB control circuit latches the receive signaling circuit in the off-hook state to operate the E relay.

(b) On-hook (positions B and C): output 1 of the TMB control circuit presets the receive signaling circuit to the on-hook state. If operated, the E relay releases.

Figure 6. 91254-02, -03, and -04 Model 2 Channel Units, Circuit Diagram (Sheet 1 of 3)

NOTES:

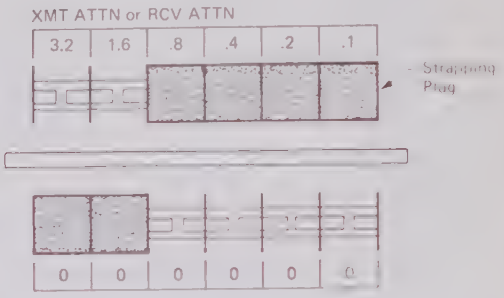
1. Strapping Options

Option			Strapping Plug Positions	
E lead during system alarm	Off-hook		A, C	
	On-hook		B, C	
	On-hook 10 seconds and then off-hook		B, D *	
M lead interface; on-hook/off-hook			02, 03	04
	Type 1, back-to-back unit; open/gnd		E	AA
	Type II, Std E&M unit; open/bat.		E	BB
	Type 1 or III, Std E&M unit; gnd/bat.		F	BB
Nominal levels at vf ports	Transmit	16 dBm	J *	
		+7 dBm	I	
	Receive	+7 dBm	H *	
		16 dBm	G	
E lead with S1 in BUSY position	Off-hook		K	
	On-hook		L	
M-lead with S1 in BUSY position (−04 only)	On-hook	Open	EE	
	Off-hook	Gnd	CC	
		Bat	DD	
E lead interface; on-hook/off-hook (E relay is shown on-hook)	Type I, Std E&M unit; open/gnd  		N, P, S, W *	
	Type 1, back-to-back unit; gnd/bat.  		M, P, R, V	
	Type II, Std E&M unit; open/closed  		N, O, S, V	
	Type III, Std E&M unit; open/gnd  		N, O, S, W	
Alarm/busy lead, 91254-03 (not usable if E&M signaling interface is type II or III)		B1-B2	P, T	
		C or OS	P, U *	
Shelf	91220-M1, -M2, and -M3 Issue 1		X	
	91220-M3 Issue 2 or 3; 91330		Y *	

*Factory strapping

2. Transmit and Receive Attenuators. Each attenuator has six sections with a total loss of 6.3 dB. Each section must have a strapping plug. Insert the plug in the socket marked with the section loss to add the loss or directly opposite in the section marked "0" to remove the loss.

   In the example below, the attenuator is shown strapped for 1.5 dB loss (.8 + .4 + .2 + .1).



3. Strapping Plugs. The channel unit is equipped with 24 single-pole strapping plugs, pn 141 56699-01.

4. Resistors and Capacitors. Unless otherwise specified. values are in ohms and microfarads

Figure 6. 91254-02, -03, and -04 Model 2 Channel Units, Circuit Diagram (Sheet 2 of 3)

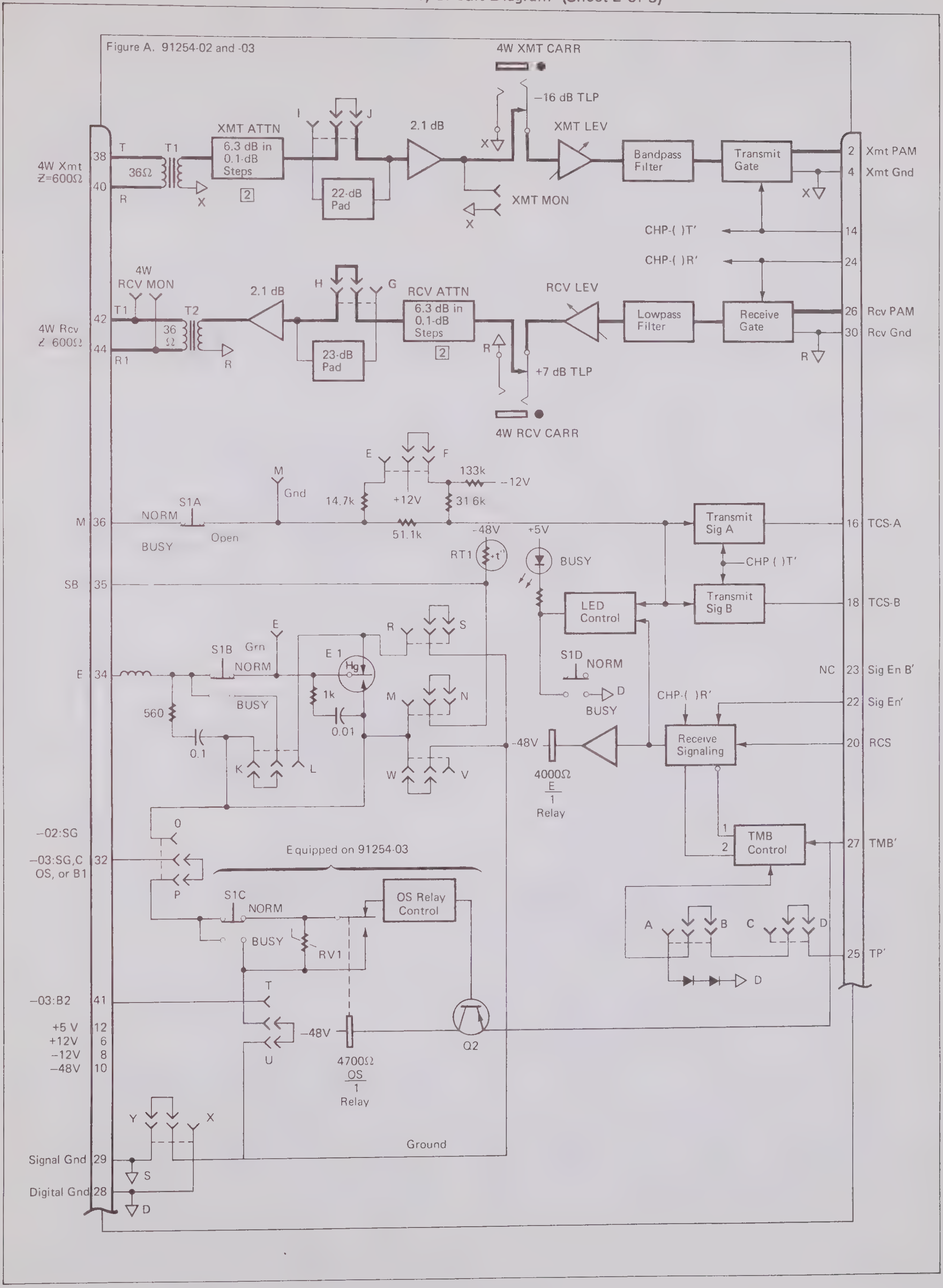


Figure A. 91254-02 and -03
4W XMT CARR
−16 dB TLP
XMT ATTN
6.3 dB in 0.1-dB Steps
2
I
J
2.1 dB
XMT LEV
Bandpass Filter
Transmit Gate
4W Xmt Z=600Ω
38
40
T
R
T1
36Ω
X
22-dB Pad
XMT MON
2 Xmt PAM
4 Xmt Gnd
CHP-( )T′
14
CHP-( )R′
24
4W RCV MON
2.1 dB
H
G
RCV ATTN
6.3 dB in 0.1-dB Steps
RCV LEV
Lowpass Filter
Receive Gate
4W Rcv Z 600Ω
42
44
T1
R1
T2
36 Ω
23-dB Pad
+7 dB TLP
26 Rcv PAM
30 Rcv Gnd
4W RCV CARR
E
F
M
Gnd
133k
−12V
14.7k
+12V
31.6k
S1A
NORM
BUSY
Open
51.1k
M 36
−48V
+5V
RT1
+t°
BUSY
Transmit Sig A
16 TCS-A
CHP ( )T′
SB 35
LED Control
Transmit Sig B
18 TCS-B
E
R
S
S1B
Grn
NORM
E 1
Hg
1k
S1D
NORM
D
BUSY
E 34
560
BUSY
M
N
0.01
CHP-( )R′
NC 23 Sig En B′
22 Sig En′
0.1
K
L
W
V
−48V
4000Ω E 1 Relay
Receive Signaling
20 RCS
−02:SG
O
−03:SG,C OS, or B1
32
P
Equipped on 91254-03
TMB Control
1
2
27 TMB′
S1C
NORM
OS Relay Control
BUSY
RV1
A
B
C
D
25 TP′
D
−03:B2
41
T
+5 V 12
+12V 6
−12V 8
−48V 10
U
−48V
4700Ω OS 1 Relay
Q2
Y
X
Ground
Signal Gnd 29
S
Digital Gnd 28
D

Figure 6. 91254-02, -03, and -04 Model 2 Channel Units, Circuit Diagram (Sheet 3 of 3)

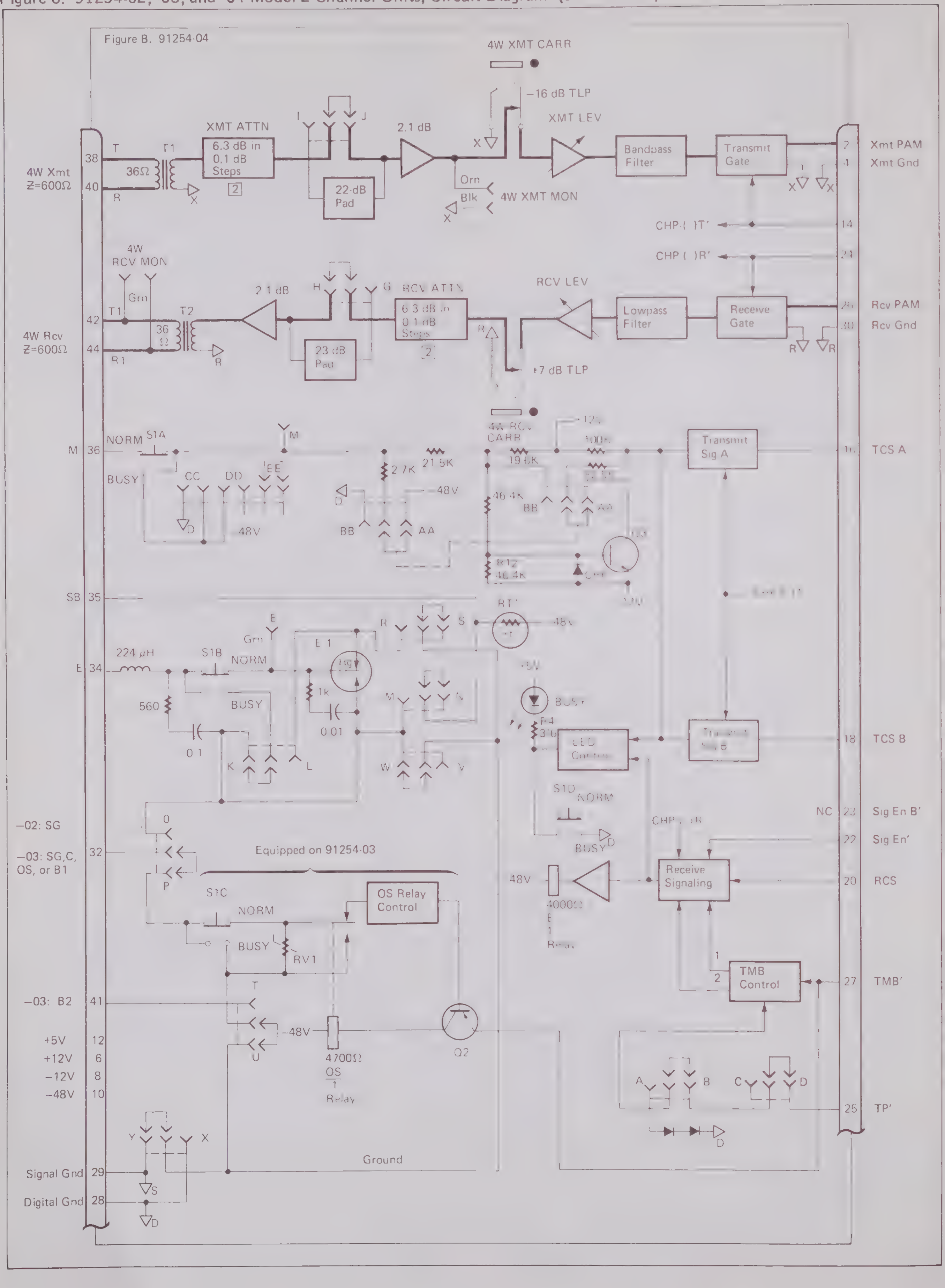


Figure B. 91254-04
4W XMT CARR
−16 dB TLP
XMT LEV
XMT ATTN
6.3 dB in 0.1 dB Steps
2
I
J
2.1 dB
X
22-dB Pad
Orn
Blk
4W XMT MON
Bandpass Filter
Transmit Gate
4W Xmt Z=600Ω
38
40
T
R
T1
36Ω
2
4
Xmt PAM
Xmt Gnd
CHP-( )T′
14
CHP-( )R′
24
4W RCV MON
Grn
T1
T2
R1
36 Ω
42
44
4W Rcv Z=600Ω
2.1 dB
H
G
RCV ATTN
6.3 dB in 0.1 dB Steps
23 dB Pad
RCV LEV
Lowpass Filter
Receive Gate
+7 dB TLP
26
30
Rcv PAM
Rcv Gnd
4W RCV CARR
M 36
NORM S1A
BUSY
CC
DD
EE
M
D
48V
2.7K
21.5K
−48V
BB
AA
19.6K
100K
46.4K
R12 46.4K
Transmit Sig A
16
TCS A
SB 35
E
Grn
R
S
RT1
−48V
E 1
224 μH
S1B
NORM
E 34
560
BUSY
1k
0.01
0.1
K
L
M
N
W
V
+5V
BUSY
R4
LED Control
Transmit Sig B
18
TCS B
S1D
NORM
BUSY
D
NC
23
Sig En B′
22
Sig En′
−02: SG
−03: SG,C, OS, or B1
32
O
P
Equipped on 91254-03
S1C
NORM
BUSY
RV1
OS Relay Control
48V
4000Ω
E 1 Relay
Receive Signaling
20
RCS
1
2
TMB Control
27
TMB′
−03: B2
41
T
U
−48V
4700Ω
OS 1 Relay
Q2
+5V 12
+12V 6
−12V 8
−48V 10
A
B
C
D
25
TP′
D
Y
X
Ground
Signal Gnd 29
Digital Gnd 28
S
D

(c) Delayed off-hook (positions B and D): first, the receive signaling circuit is preset to the on-hook state. After 10 seconds, a single 40-ms pulse on the TP' lead activates output 2 of the TMB control circuit and the E relay operates.

3.20 Alarm/Busy Leads on 91254-03. If a type I signaling interface has been selected, the O/P strapping plug is inserted in position P, freeing pin 32 for use as a C, OS, or B1 lead. The arrangement is completed by inserting the T/U strapping plug in position T (B1 and B2 leads) or position U (C or OS lead). With the NORM/BUSY pushbutton in NORM position, pin 32 is controlled in the following manner when a system alarm occurs.

(a) If pin 32 is a C lead and the trunk is idle, or if pin 32 is an OS or B1 lead, the lead is ungrounded externally and the OS relay control circuit is applying negative bias to the base of transistor Q2. When TMB' is grounded by the system alarm, Q2 turns on and operates the OS relay, which grounds pin 32 (C or OS) or closes pins 32 and 41 (B1 and B2).

(b) If pin 32 is a C lead and the trunk is busy, the C lead is grounded by the external switching equipment and the OS relay control circuit outputs positive bias to the base of Q2. When TMB' is grounded by the system alarm, the OS relay does not operate. If the switching equipment ungrounds the C lead, after a 50-millisecond delay, the control circuit output changes to negative bias. Transistor Q2 operates the OS relay, grounding the C lead until the system alarm ends.

3.21 Depressing the NORM/BUSY pushbutton to BUSY position grounds the external C or OS lead or closes B1 and B2.

4. INSTALLATION

4.01 The 91254 can be installed in any channel unit slot of the 91220-01 or -02 or the 91330-01, -02, or -04 Terminal Equipment Shelf. Handle channel units carefully to avoid damaging components mounted on the printed circuit board. Spare units should be stored in the shipping boxes or in a spare shelf. Never stack unboxed channel units.

Installer Wiring

4.02 If the shelf is 91220-01 or 91330-01 or -04, wire the following external circuits, as applicable, to receptacle connectors J1-J12 for channels 1-12 and J17-J28 for channels 13-24.

(a) Four-wire transmit: T/R to pins 38/40

(b) Four-wire receive: T1/R1 to pins 42/44

(c) E&M signaling interface type I: E to pin 34 and M to pin 36

(d) E&M signaling interface type II or III, 91254-02 or -03 model 2: SG/E to pins 32/34 and SB/M to pins 35/36

(e) Alarm/busy leads, 91254-01 model 1: OS to pin 32, or B1/B2 to pins 32/41

(f) Alarm/busy leads, 91254-01, -03, or -04 model 2 (E&M signaling interface must be type I): C or OS to pin 32, or B1/B2 to pins 32/41

(g) Alarm/busy leads, 91254-02 model 2: none

4.03 If the shelf is 91220-02 or 91330-02, the circuits listed above are accessible at 50-pin receptacle connectors J30 through J34. Factory wiring connects pins 38/40 (of J1-J12 and J17-J28) to J30, pins 34/32 to J31, pins 35/36 to J32, pins 42/44 to J33, and pins 39/41 to J34. See Section 342-911-103 (91220-02) or Section 342-911-107 (91330-02) for cabling information.

Strapping

4.04 Channel Unit. Strap the channel unit for the applicable options tabulated on figure 4, 5, or 6.

4.05 Shelf. Refer to figure 7 for possible changes to factory-strapping on J1-J12 and J17-J28 to properly condition the trunk when the channel unit is removed from the shelf.

Alignment

4.06 Refer to Part 5 for information on vf level adjustment and pulsing tests over the carrier.

5. MAINTENANCE

5.01 Detailed alignment, testing, and troubleshooting information is contained in Section 342-911-109.

VF Levels

5.02 The 91254 channel unit is aligned at the four-wire jacks by setting the vf receive level first and then the vf transmit level. The detailed procedures in Section 342-911-109 are summarized below, following which, special instructions for the various channel unit versions are given.

(a) With the channel unit receiving a digital test tone from the 91232 test set, the RCV LEV control is adjusted for +7.0 dBm at the 4W RCV jack.

(b) In the loop test mode of the channel bank, the channel units transmit to each other in pairs. With a —16.0 dBm test tone inserted at the 4W XMT jack, the XMT LEV control is adjusted for +7.0 dBm at the 4W RCV jack of the paired unit on which the receive level has already been set. If the system is in operation and the channel bank cannot be looped back, the XMT LEV control can be adjusted for the required level at a receive TLP on the far-end channel unit.

5.03 91254-01 Model 1. Because the transmission level points (TLP) on the model 1 channel unit are —16.7 dB and +7.7 dB at the 4W XMT and 4W RCV jacks, respectively, the 91232 test set must be connected to these jacks through a 91256 Test Level Adapter. The 91256 inserts a 0.7-dB pad to coordinate the test set and channel unit levels.

5.04 91254-01 Model 2. Levels are measured at the 4W XMT MON and 4W RCV MON pin jacks. Depress the NORM/BUSY pushbutton to disconnect the office equipment.

5.05 91254-02, -03, and -04 Model 2. Levels at the vf ports are coordinated with —16 dB and +7 dB TLP's at the CARR jacks by strapping the transmit and receive attenuators as explained in Part 2. Also, the I/J and G/H strapping plugs are inserted according to the 91254 application as a standard E&M unit or a back-to-back unit. See figure 6 for strapping instructions.

Figure 7. TMB Strapping on the 91220 and 91330 Terminal Equipment Shelves

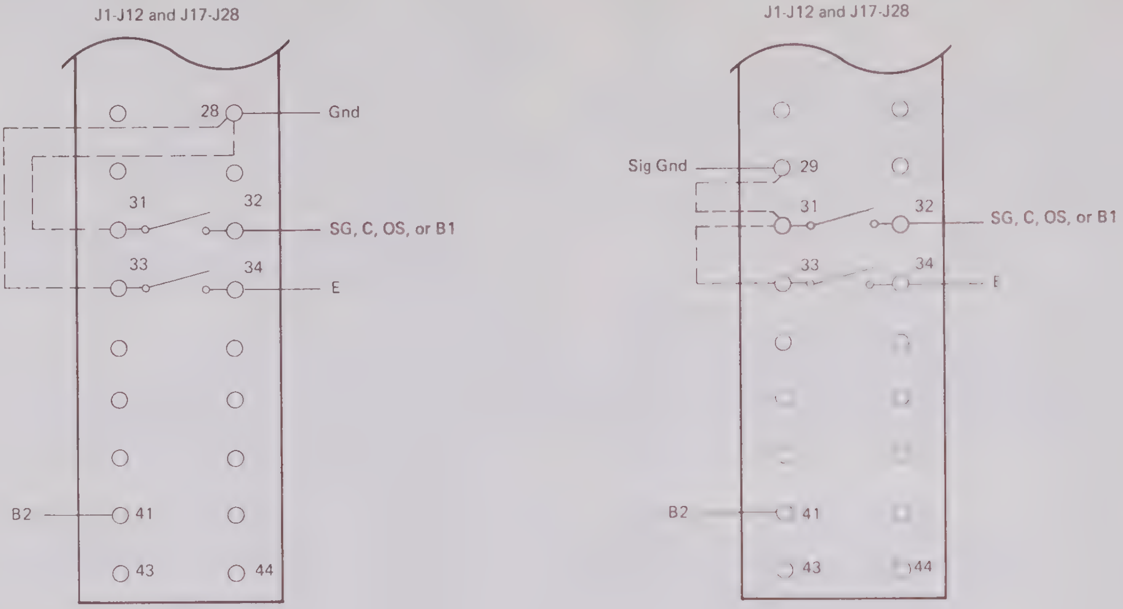


Figure A. 91220-M1, -M2, and -M3 Issue 1

Figure B. 91220-M3 Issues 2 and 3; 91330-01, -02 and -04

NOTES:

1. Factory Strapping. Figures A and B show factory strapping on channel unit receptacle connectors J1-J12 and J17-J28 for channels 1-24. When a channel unit is unplugged, switching contacts 31-32 and 33-34 close ground to the receive signaling leads and the alarm/busy leads, if used.

2. End Office. Changes to the factory strapping may be required at an end office so that the trunk circuit will be conditioned to idle or busy, as applicable, when a channel unit is unplugged. Refer to the table below.

Trunk	Signaling Interface	Alarm/Busy Leads	Figure A	Figure B
One-way outgoing or two-way	Type I	None, C, or OS	No change	No change
		B1-B2	Remove 28-31; strap 31-41	Remove 29-31 and 31-33; strap 29-33 and 31-41
	Type II	Not applicable	Remove 28-31 and 28-33; strap 31-33	Remove 29-31
	Type III		No change	No change
One-way incoming	Type I	None or OS	Remove 28-33	Remove 31-33
		B1-B2	Remove 28-31 and 28-33; strap 31-41	Remove 29-31 and 31-33; strap 31-41
		C	Remove 28-31 and 28-33	Remove 29-31 and 31-33
	Type II	Not applicable	Remove 28-31 and 28-33	Remove 29-31 and 31-33
	Type III		Remove 28-33	Remove 31-33

3. Tandem Office. Changes to the factory strapping at a tandem office should not be necessary. Removal of a channel unit may produce an on-hook or off-hook on the E lead depending on the signaling option. Therefore, the trunk should be conditioned at the end office before a channel unit is removed at a tandem office.

Pulsing Tests

5.06 Figure 8 gives procedures for measuring dial pulse signaling distortion over the carrier channel on an end-to-end basis. For loopback testing, refer to Section 342-911-109.

Figure 8. Dial Pulse Signaling Distortion Test

DESCRIPTION OF TEST:

Continuous pulses are transmitted from each terminal and the percent break is measured at the receive terminal. For procedures at the distant terminal, refer to the GTEP Section applicable to the channel unit there.

TEST EQUIPMENT:

26600 Signaling Test Set

725A Cord:	two-conductor low-resistance cable, 3.7 m (12 feet) long; 310-type plug on each end.
729A Cord:	shielded pair, 2.4 m (8 feet) long; 310-type plug to twin pin plug.

Step	Procedure
1	Signaling Test Set
1a	Connect 48V/GRD jack to office battery with 725A Cord.
1b	Set all red-handled keys to center position.
1c	Set E key to O/G and M key to B/G.
1d	Set toggle switch to DIAL PULSE.
1e	Adjust SET FULL SCALE control for meter reading of 0% break.
1f	Set toggle switch to CONT PULSE.
1g	Turn both ADJ % BREAK controls, COARSE and FINE, full clockwise.
1h	While depressing PRESS TO MEASURE SPEED pushbutton, adjust FINE control for steady meter reading, and then adjust ADJ SPEED control for reading of 12 pulses per second. Release pushbutton.
1i	Adjust COARSE and FINE controls for meter reading of 60.5% break.
1j	Because controls are interacting, repeat steps 1h and 1i.
2	Trunk Conditioning
2a	91254 model 1: condition the trunk for testing by means of the office equipment.
2b	91254 model 2: depress NORM/BUSY pushbutton to condition the trunk for testing.
3	Test Setup
	NOTE: The signaling interface on 91254-01 is type I Std E&M; for description of the interface options on 91254-02, -03 or -04, see Note 1 of figure 6.
3a	Any signaling interface except type I back-to-back: connect test set LINE jack to channel unit E&M pin jacks with a 729A Cord. The tip lead of the cord must go to the E pin jack. (On the 729A, the tip side of the twin pin plug is marked by an index.)
3b	Type I back-to-back interface: connect test set DROP jack to channel unit E&M pin jacks with a 729A Cord. The tip lead of the cord must go to the M pin jack. (On the 729A, the tip side of the twin pin plug is marked by an index.)
4	Sending Pulses to the Carrier
4a	Any signaling interface except type I back-to-back: set M key to B/G, TWD LINE key to OFF HOOK, and PULSE key to LINE.
	NOTE: Because the SB lead is not accessible, the type II interface is tested with ground/battery (on-hook/off-hook) pulsing on the M lead.
4b	Type I back-to-back interface: set E key to O/G and PULSE key to DROP. (M key is not applicable.)
4c	Channel unit is now pulsing the M lead at 12 pps and 60.5% break.
4d	Pulses measured at the distant terminal should be according to the distant channel unit type. Refer to the applicable GTEP Section.
5	Measuring Pulses from the Carrier
5a	Have the distant terminal send a steady off-hook.
	NOTE: The E key and M key settings have no effect on pulse measurement.
5b	Any signaling interface except type I back-to-back: set MEASURE key to LINE.
5c	Type I back-to-back interface: set MEASURE key to DROP.
5d	Adjust SET FULL SCALE control for meter reading of 0% break.
5e	Have the distant terminal send continuous pulses at 12 pps and 60.5% break.
5f	Test set meter should read according to distant channel unit type as follows: E&M channel unit: 58.5% to 62.5% break DPO channel unit: 50% to 74% break
6	Restore channel to operation.
7	To test another channel unit, return to step 2.

GTE LENKURT

Company Headquarters and
Manufacturing Facility

1105 County Road
San Carlos, California 94070
Phone 415—595-3000

Albuquerque
Manufacturing Facility

One Camino de Lenkurt
Albuquerque, New Mexico 87123
Phone 505—296-0551

El Paso
Manufacturing Facility

10727 Gateway West
El Paso, Texas 79935
Phone 915 -593-3400

District
Sales Offices

1105 County Road
San Carlos, California 94070
Phone 415 -595 3000

120 West Eastman Street
Arlington Heights, Illinois 60004
Phone 312—398-6700

542 Haggard Street, Suite 510
Plano, Texas 75074
Phone 214—422-4305

7950 Woodruff Court
Springfield, Virginia 22151
Phone 703—321-8560

5780 Peachtree-Dunwoody Road, N.E
Suite 145
Atlanta, Georgia 30342
Phone 404 256 3000

GTE International
Sales Office

1105 County Road
San Carlos, California 94070
Phone 415—595 3000
Cable: GENTELINT

GTE LENKURT

TR-014-200
Issue 1
October, 1974

TV GUIDE

"INTRODUCTION TO BINARY LOGIC"

20 Min.

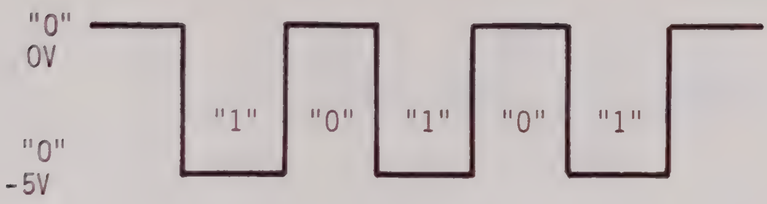
General: This TV Guide is intended as an aid to note taking. The contents of the guide form a review sheet of the video tape material.

1. Logic gates are binary devices. This means that their inputs and outputs are allowed to exist in only two states. (On-Off, Closed-Open, etc.)

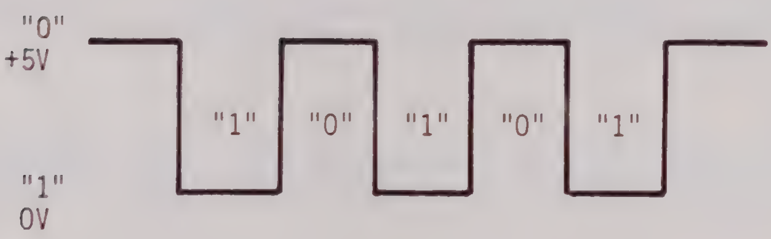
2. Binary Terminology:

	1	2	3	4
One State	True	ON	Pulse	Logic 1
Other State	False	Off	No Pulse	Logic 0

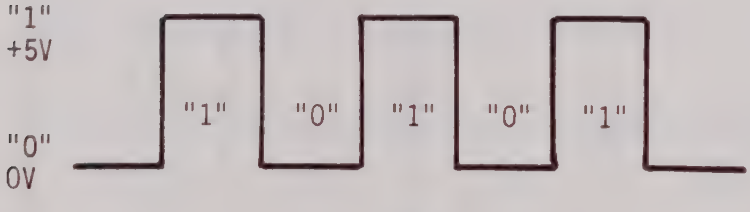
3. Negative Pulse Logic - "1" More Neg. than "0"


"0"
0V
"0"
-5V
"1"
"0"
"1"
"0"
"1"

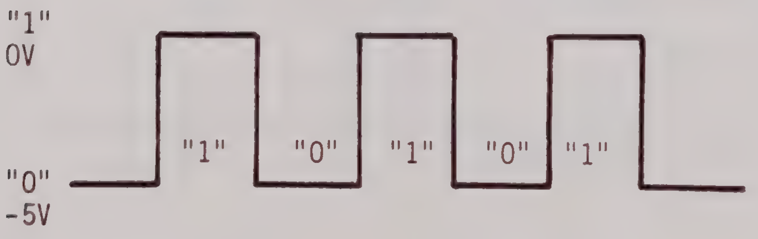
OR


"0"
+5V
"1"
0V
"1"
"0"
"1"
"0"
"1"

4. Positive Pulse Logic - "1" More Pos. than "0"


"1"
+5V
"0"
0V
"1"
"0"
"1"
"0"
"1"

OR


"1"
0V
"0"
-5V
"1"
"0"
"1"
"0"
"1"

5. Gate Types:

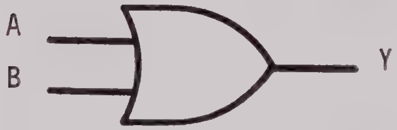
   a. Linear or Transmission
   b. Logic

6. Truth Tables are graphic representations of the Truth Statement for any gate or combination of gates.

7. The Truth Statement is a verbal description of a circuit's input conditions required to make its output go to logic "1" state.

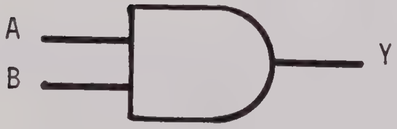
8. Logic Gate Symbols and Truth Tables

a. OR GATE



A	B	Y
0	0	0
1	0	1
0	1	1
1	1	1

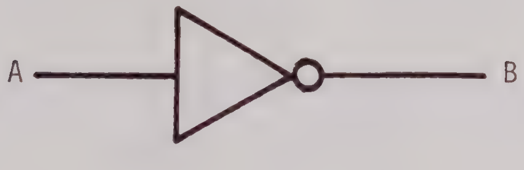
b. AND GATE



A	B	Y
0	0	0
1	0	0
0	1	0
1	1	1

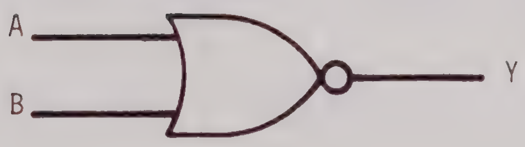
8. Logic Gate Symbols and Truth Tables (Continued).

c. INVERTER



A	B
1	0
0	1

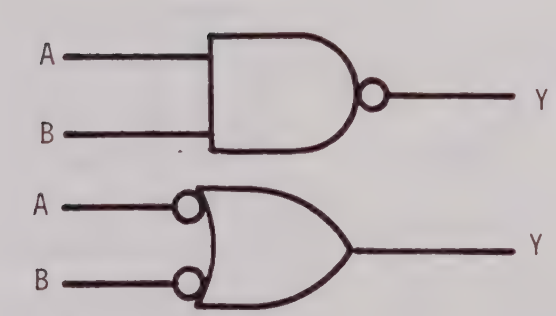
d. NOR GATE



"Not Or Logic 1's"

A	B	Y
0	0	1
1	0	0
0	1	0
1	1	0

e. NAND GATE



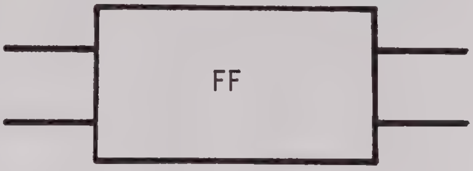
"Not And Logic 1's"

A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0

9. Flip-Flops are bi-stable switching elements.

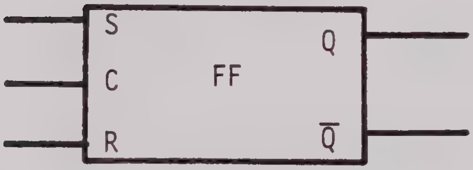
10. General Flip-Flop Rules:

a. The letters FF will normally appear in the symbol.



b. A Flip-Flop is assumed to be the simple reset-set type if no other identification is made, and when a clock input is added identifying letters are placed inside the symbol to identify the lead functions.

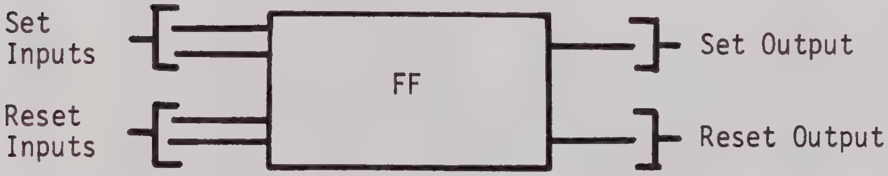
Reset-Set (R/S)
W/Clock


S
C
R
FF
Q
$\overline{Q}$

S = Set
C = Clock
R = Reset
Q = Set Output
$\overline{Q}$ = Reset Output

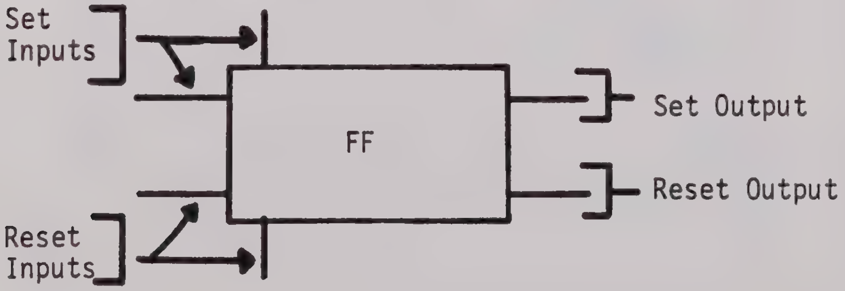
c. Multiple inputs on the same side of the symbol are enabled with the logical "AND" condition.

"And" Required


Set Inputs
Reset Inputs
FF
Set Output
Reset Output

d. Inputs diagonally on the corners of the symbol require the logical "OR" condition to be enabled.

"Or" Required

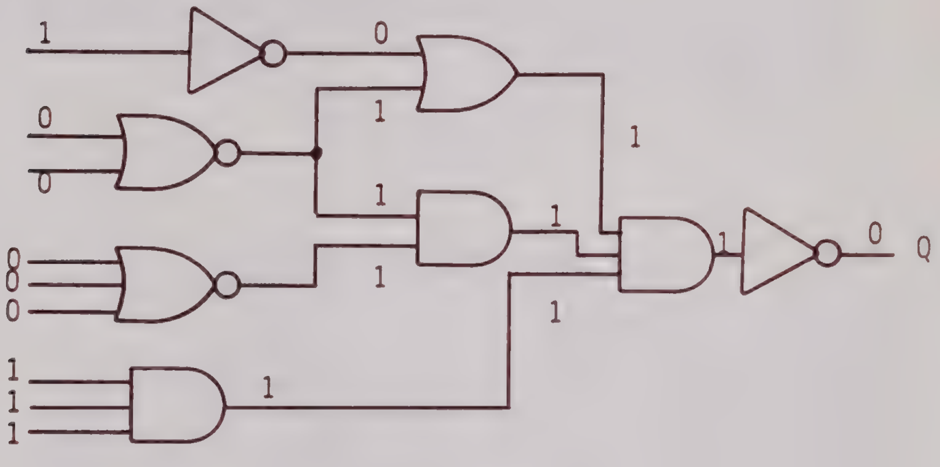

Set Inputs
Reset Inputs
FF
Set Output
Reset Output

11. Simple logic circuit analysis steps:

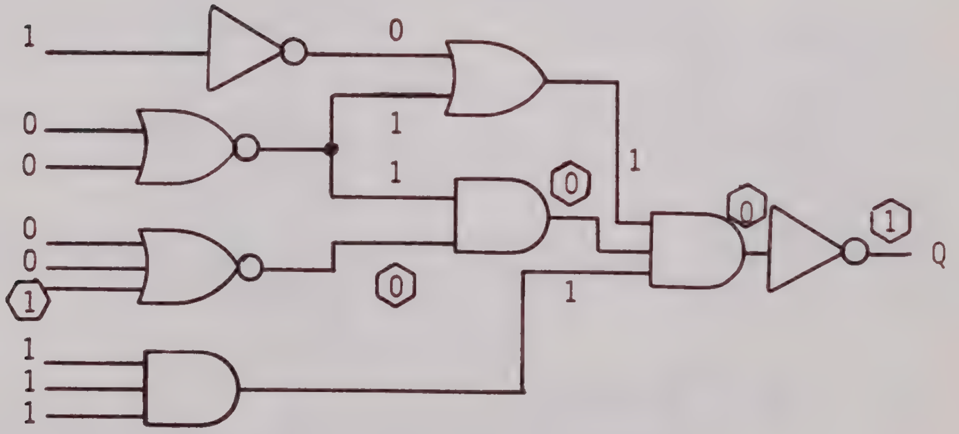
    a. Determine all circuit normal conditions or states.

    b. Change one input at a time to determine what the resulting output changes should be.

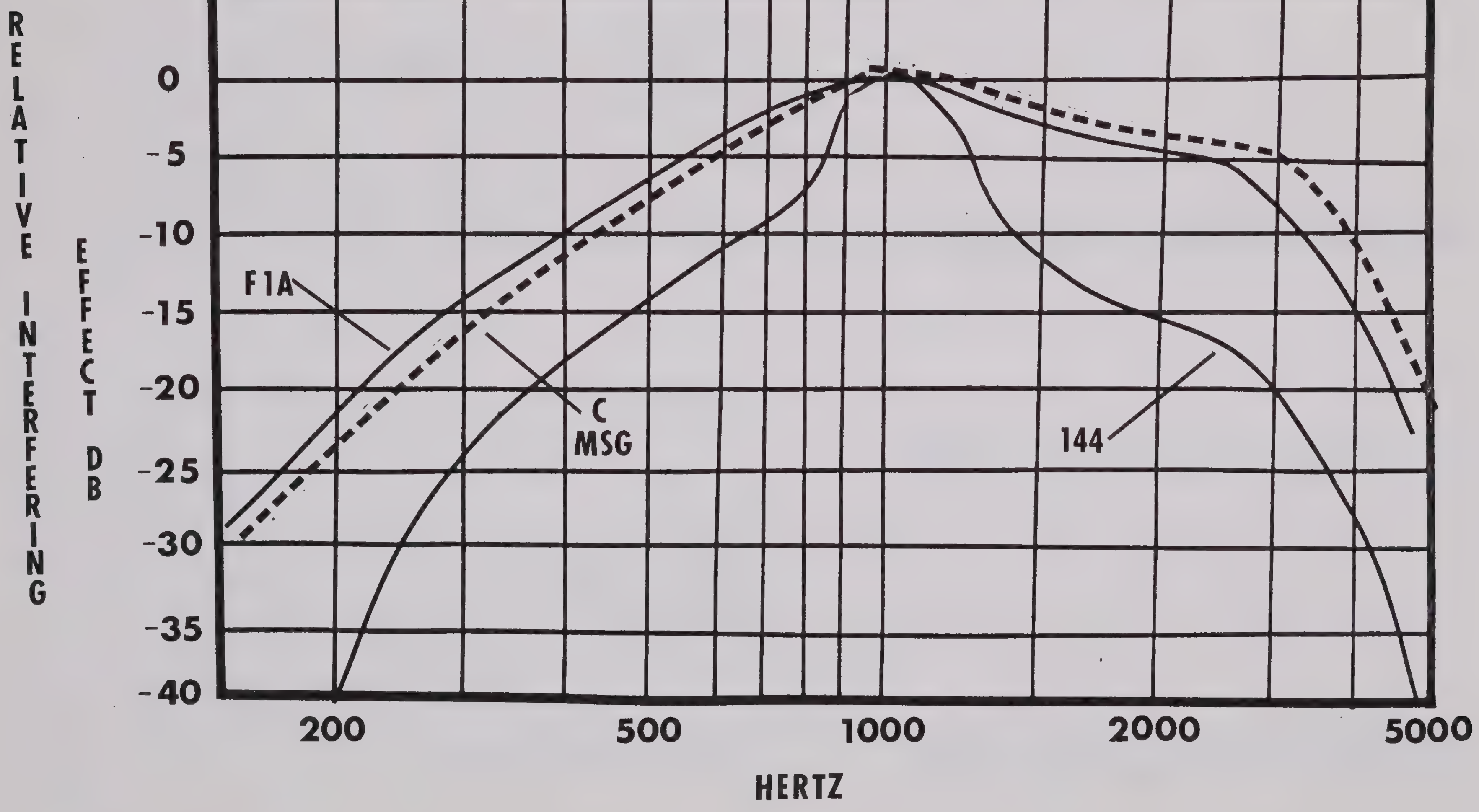
CIRCUIT NORMAL


1
0
0
0
0
0
1
1
1
0
1
1
1
1
1
1
1
1
0
Q

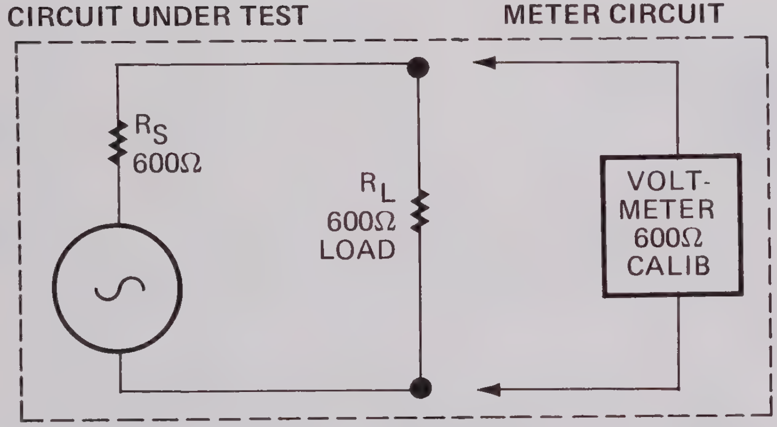
ONE INPUT CHANGE


1
0
0
0
0
1
1
1
1
0
1
1
0
1
0
0
1
1
Q

WEIGHTING CURVES

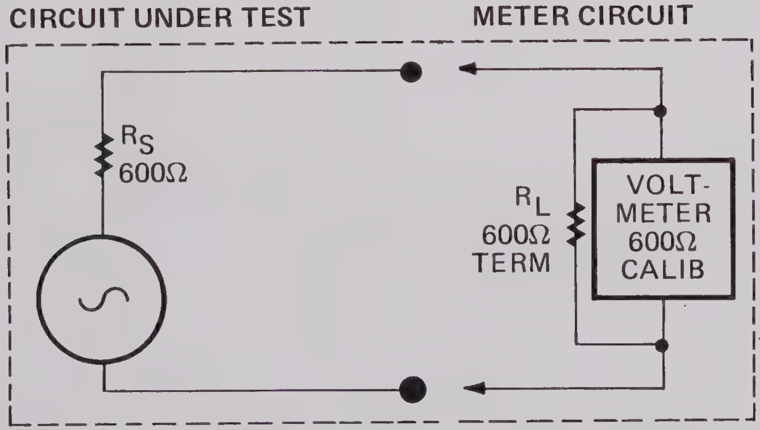


600 Ω POWER MEASUREMENTS


CIRCUIT UNDER TEST
METER CIRCUIT
R_S
600Ω
R_L
600Ω
LOAD
VOLT-
METER
600Ω
CALIB

BRIDGING MEASUREMENT = METER CONNECTED ACROSS A SOURCE THAT IS WORKING INTO ITS NATURAL LOAD IMPEDANCE.

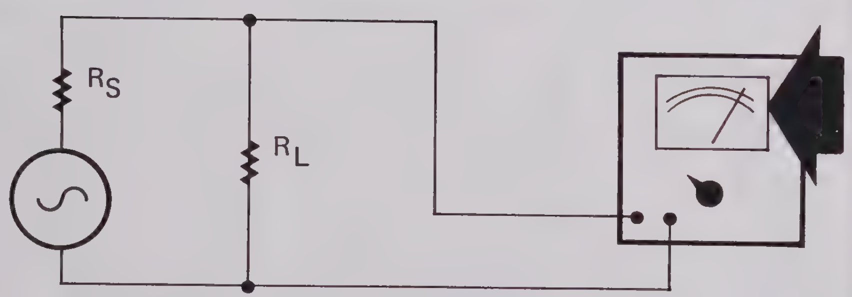
METER IS CALIBRATED FOR POWER ACROSS 600Ω, AND WILL READ dBm DIRECTLY.


CIRCUIT UNDER TEST
METER CIRCUIT
R_S
600Ω
R_L
600Ω
TERM
VOLT-
METER
600Ω
CALIB

TERMINATED MEASUREMENT = METER CONNECTED INTO AN OPEN CIRCUIT, SO MATCHING LOAD RESISTOR MUST BE SUPPLIED.

METER IS CALIBRATED FOR POWER ACROSS 600Ω, AND WILL NOW READ dBm DIRECTLY.

CORRECTION FACTORS



VOLTMETER WITH dB SCALE CALIB.
FOR POWER MEASUREMENTS
WHEN $R_L = 600\Omega$.

WHEN $R_L \neq 600\Omega$,
METER READING WILL BE
AND MUST BE CORRECTED BY

CORRECTION	R_L	METER READING
−3.0 dB	1200Ω	3.00 dB HIGH
−1.8 dB	900Ω	1.75 dB HIGH
NONE – READ dBm ON SCALE	600Ω	dBm DIRECTLY
+3.0 dB	300Ω	3.0 dB LOW
+6.5 dB	130Ω	6.5 dB LOW
+9.0 dB	75Ω	9.0 dB LOW

NOTE: ALL READINGS AND CORRECTIONS DEPEND ON R_S BEING EQUAL TO R_L.

NOISE UNIT COMPARISON CHART

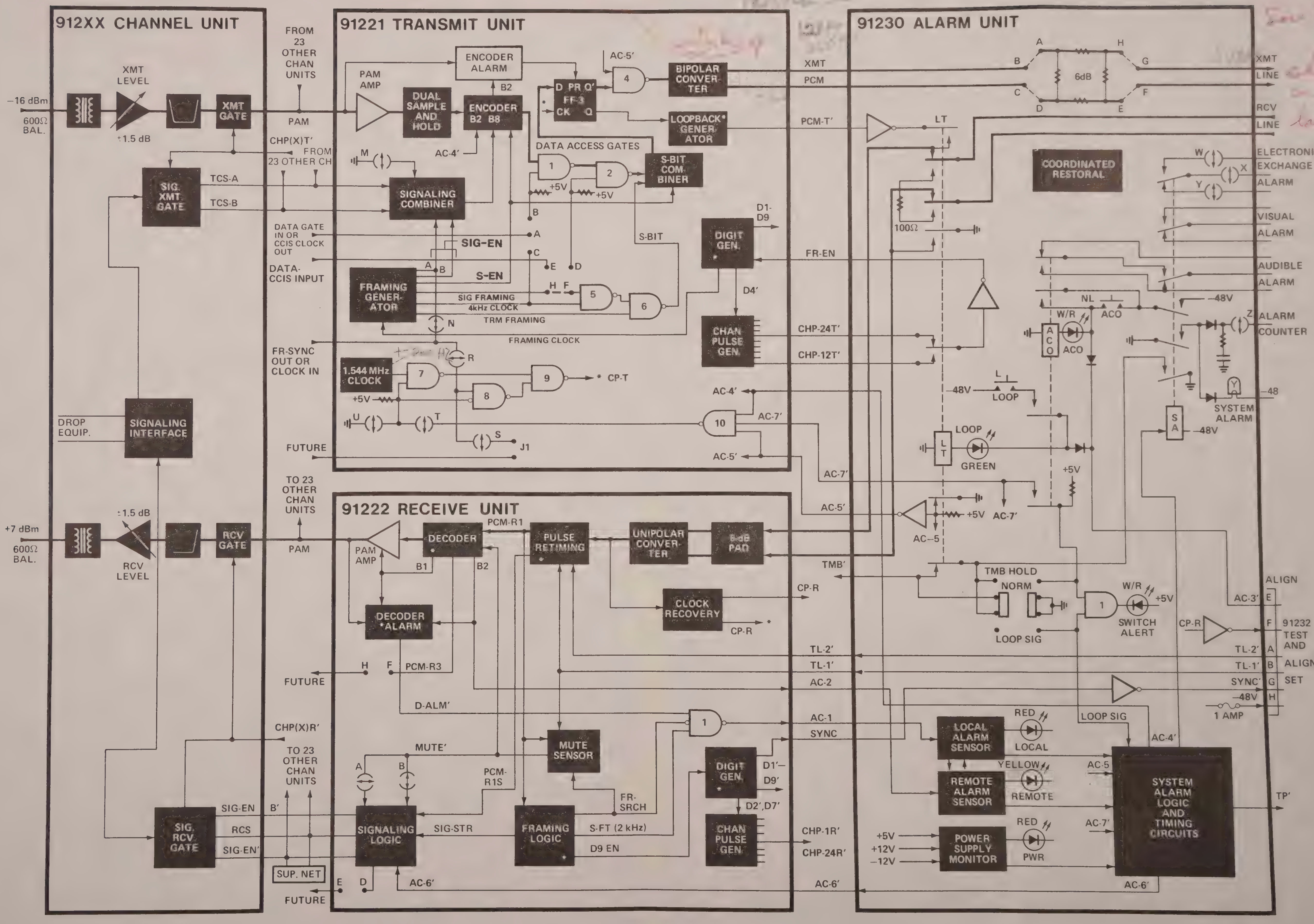
DOMESTIC (U.S.)					INTERNATIONAL	
USING "C" MSG. FILTER			USING 3.1 KHz FILTER		USING 1.74 KHz FILTER	
dBrnc0	dBm0c	pWc0	dBm0	S/N dB	pWp0	dBm0p
0	-90	1.0	-88.3	88.3	.8	-90.8
1	-89	1.3	-87.3	87.3	1.0	-89.8
2	-88	1.6	-86.3	86.3	1.3	-88.8
3	-87	2.0	-85.3	85.3	1.7	-87.8
4	-86	2.5	-84.3	84.3	2.1	-86.8
5	-85	3.2	-83.3	83.3	2.6	-85.8
6	-84	4.0	-82.3	82.3	3.3	-84.8
7	-83	5.0	-81.3	81.3	4.2	-83.8
8	-82	6.3	-80.3	80.3	5.3	-82.8
9	-81	7.9	-79.3	79.3	6.6	-81.8
10	-80	10.0	-78.3	78.3	8.3	-80.8
11	-79	12.6	-77.3	77.3	10.5	-79.8
12	-78	15.8	-76.3	76.3	13.2	-78.8
13	-77	19.9	-75.3	75.3	16.6	-77.8
14	-76	25.1	-74.3	74.3	20.9	-76.8
15	-75	31.6	-73.3	73.3	26.3	-75.8
16	-74	39.8	-72.3	72.3	33.1	-74.8
17	-73	50.1	-71.3	71.3	41.7	-73.8
18	-72	63.1	-70.3	70.3	52.5	-72.8
19	-71	79.4	-69.3	69.3	66.1	-71.8
20	-70	100.0	-68.3	68.3	83.2	-70.8
21	-69	125.9	-67.3	67.3	104.7	-69.8
22	-68	158.5	-66.3	66.3	131.8	-68.8
23	-67	199.5	-65.3	65.3	165.9	-67.8
24	-66	251.2	-64.3	64.3	208.9	-66.8
25	-65	316.2	-63.3	63.3	263.2	-65.8
26	-64	398.1	-62.3	62.3	331.1	-64.8
27	-63	501.2	-61.3	61.3	416.9	-63.8
28	-62	630.9	-60.3	60.3	524.8	-62.8
29	-61	794.3	-59.3	59.3	660.7	-61.8
30	-60	1000.0	-58.3	58.3	831.8	-60.8
31	-59	1258.9	-57.3	57.3	1047.1	-59.8
32	-58	1584.9	-56.3	56.3	1318.3	-58.8
33	-57	1995.3	-55.3	55.3	1659.6	-57.8
34	-56	2511.9	-54.3	54.3	2089.3	-56.8
35	-55	3162.3	-53.3	53.3	2630.3	-55.8
36	-54	3981.1	-52.3	52.3	3311.3	-54.8
37	-53	5011.9	-51.3	51.3	4168.7	-53.8
38	-52	6309.6	-50.3	50.3	5248.1	-52.8
39	-51	7943.3	-49.3	49.3	6606.9	-51.8
40	-50	10000.0	-48.3	48.3	8317.6	-50.8
41	-49	12589.3	-47.3	47.3	10471.3	-49.8
42	-48	15848.9	-46.3	46.3	13182.6	-48.8
43	-47	19952.6	-45.3	45.3	16595.9	-47.8
44	-46	25118.9	-44.3	44.3	20893.0	-46.8
45	-45	31622.8	-43.3	43.3	26302.7	-45.8
46	-44	39810.7	-42.3	42.3	33113.1	-44.8
47	-43	50118.7	-41.3	41.3	41686.9	-43.8
48	-42	63095.7	-40.3	40.3	52480.7	-42.8
49	-41	79432.8	-39.3	39.3	66069.3	-41.8
50	-40	100000.0	-38.3	38.3	83176.4	-40.8
51	-39	125892.5	-37.3	37.3	104712.9	-39.8
52	-38	158489.3	-36.3	36.3	131825.7	-38.8
53	-37	199526.2	-35.3	35.3	165958.7	-37.8
54	-36	251188.6	-34.3	34.3	208929.6	-36.8
55	-35	316227.8	-33.3	33.3	263026.8	-35.8
56	-34	398107.2	-32.3	32.3	331131.1	-34.8
57	-33	501187.2	-31.3	31.3	416869.4	-33.8
58	-32	630957.3	-30.3	30.3	524807.5	-32.8
59	-31	794328.2	-29.3	29.3	660693.4	-31.8
60	-30	1000000.0	-28.3	28.3	831763.8	-30.8

All units are referenced to test tone level of zero dBm.

dBrnc0 = 10 log pWp0 + .8 = dBm0p + 90.8 = 88.3 -S/N =

9002B PCM TERMINAL

Transfer Cap.



912XX CHANNEL UNIT
-16 dBm
600Ω BAL.
XMT LEVEL
±1.5 dB
XMT GATE
SIG. XMT GATE
TCS-A
TCS-B
SIGNALING INTERFACE
DROP EQUIP.
+7 dBm
600Ω BAL.
±1.5 dB
RCV LEVEL
RCV GATE
SIG. RCV GATE
SIG-EN
RCS
SIG-EN'
FROM 23 OTHER CHAN UNITS
PAM
CHP(X)T'
FROM 23 OTHER CH
DATA GATE IN OR CCIS CLOCK OUT
DATA-CCIS INPUT
FR-SYNC OUT OR CLOCK IN
FUTURE
TO 23 OTHER CHAN UNITS
CHP(X)R'
SUP. NET
91221 TRANSMIT UNIT
PAM AMP
DUAL SAMPLE AND HOLD
ENCODER ALARM
ENCODER B2 B8
B2
AC-4'
AC-5'
D PR Q' FF-3 CK Q
BIPOLAR CONVERTER
LOOPBACK* GENERATOR
DATA ACCESS GATES
S-BIT COMBINER
SIGNALING COMBINER
M
+5V
SIG-EN
S-EN
S-BIT
FRAMING GENERATOR
SIG FRAMING
4kHz CLOCK
TRM FRAMING
FRAMING CLOCK
DIGIT GEN.
D1-D9
D4'
CHAN PULSE GEN.
1.544 MHz CLOCK
R
N
U
T
S
J1
* CP-T
AC-7'
XMT PCM
PCM-T'
FR-EN
CHP-24T'
CHP-12T'
91222 RECEIVE UNIT
PAM AMP
DECODER
PCM-R1
B1
B2
PULSE RETIMING
UNIPOLAR CONVERTER
6 dB PAD
CLOCK RECOVERY
CP-R
DECODER *ALARM
H F
PCM-R3
D-ALM'
MUTE'
MUTE SENSOR
PCM-R1S
FR-SRCH
SIGNALING LOGIC
SIG-STR
FRAMING LOGIC
S-FT (2 kHz)
D9 EN
DIGIT GEN.
D1'-D9'
D2',D7'
CHAN PULSE GEN.
AC-6'
B'
E D
TMB'
TL-2'
TL-1'
AC-2
AC-1
SYNC
CHP-1R'
CHP-24R'
91230 ALARM UNIT
A B C D E F G H
6dB
XMT LINE
RCV LINE
LT
100Ω
COORDINATED RESTORAL
W X Y
ELECTRONIC EXCHANGE ALARM
VISUAL ALARM
AUDIBLE ALARM
NL ACO
-48V
W/R ACO
Z
ALARM COUNTER
SYSTEM ALARM
-48
S A
LOOP
GREEN
-48V
+5V
AC-5'
AC-7'
AC-5
TMB HOLD
NORM
LOOP SIG
W/R
SWITCH ALERT
ALIGN
AC-3'
CP-R
91232 TEST AND ALIGN. SET
SYNC'
1 AMP
RED LOCAL
LOCAL ALARM SENSOR
YELLOW REMOTE
REMOTE ALARM SENSOR
RED PWR
POWER SUPPLY MONITOR
+5V +12V -12V
AC-4'
AC-5
AC-7'
AC-6'
SYSTEM ALARM LOGIC AND TIMING CIRCUITS
TP'

FDM–ANALOG TRANSMISSION

AN ELECTRICAL CARRIER
WAVE IS VARIED CONTINUOUSLY
IN PROPORTION TO SPEECH
OR INTELLIGENCE SIGNALS.
(AMPLITUDE, PHASE, OR FREQUENCY)

TDM—DIGITAL TRANSMISSION

THE PRESENCE OR ABSENCE
OF A DIGITAL PULSE IN A
SERIES OF TIME SLOTS
CONVEYS THE INFORMATION.

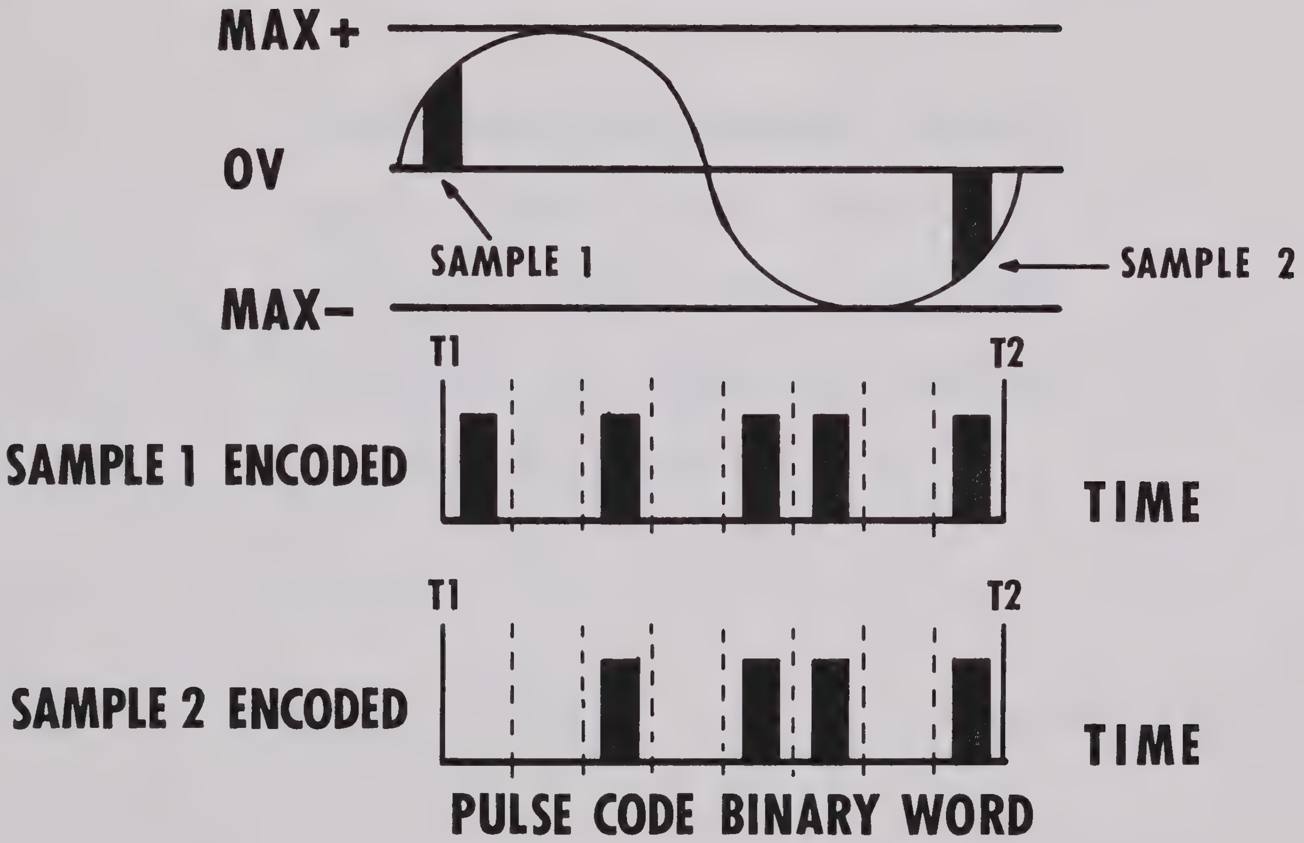
TIME DIVISION MULTIPLEX

1. PAM–PULSE AMPLITUDE MODULATION
2. PPM–PULSE POSITION MODULATION
3. PWM–PULSE WIDTH MODULATION
4. PCM–PULSE CODE MODULATION
5. DELTA– INCREMENTAL CHANGE MODULATION

TR–911–209 △

PCM

PULSE CODE MODULATION


MAX +
OV
MAX−
SAMPLE 1
SAMPLE 2
T1
T2
SAMPLE 1 ENCODED
TIME
T1
T2
SAMPLE 2 ENCODED
TIME
PULSE CODE BINARY WORD

TR-911-214 △1

PULSE CODE MODULATION

TRANSFORMING CONTINUOUSLY VARIABLE SPEECH SIGNALS INTO A SERIES OF DIGITALLY CODED PULSES AND THEN REVERSING THE PROCESS TO RECOVER THE ORIGINAL INFORMATION.

DECIMAL SYSTEM

POWER OF 10 MULTIPLIER

POSITION WEIGHT

POSITION	X ←	5	4	3	2	1
MULTIPLIER	10^{X-1}	10^4	10^3	10^2	10^1	10^0

0
1
2
3
4
5
6
7
8
9

10 WEIGHTED VALUES ARE POSSIBLE IN EACH POSITION

THEREFORE THE DECIMAL NUMBER:

1264

EQUALS

$$1 \times 10^3 + 2 \times 10^2 + 6 \times 10^1 + 4 \times 10^0 \text{ or } \begin{array}{r} 1000 \\ 200 \\ 60 \\ 4 \\ \hline 1264 \end{array}$$

DECIMAL NUMBER 1264

TR-911-223 △1

BINARY SYSTEM

POWER OF 2 MULTIPLIER

POSITION	X ←	5	4	3	2	1
MULTIPLIER	2^{X-1}	2^4	2^3	2^2	2^1	2^0

POSITION WEIGHT

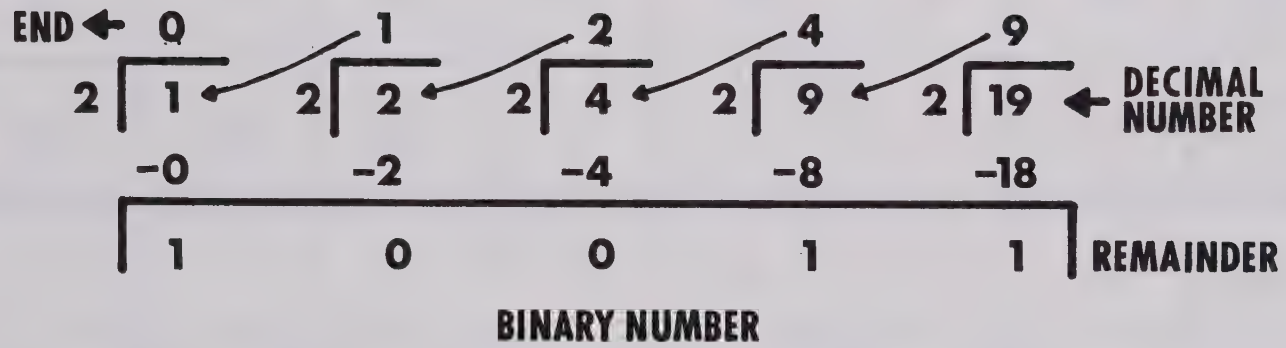
$\left.\begin{matrix}0\\1\end{matrix}\right]$ — ONLY 2 WEIGHTED VALUES ARE POSSIBLE IN EACH POSITION

THEREFORE THE BINARY NUMBER:
1101
EQUALS

$$1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 \text{ or } \begin{array}{r} 8 \\ 4 \\ 0 \\ +\ 1 \\ \hline 13 \end{array}$$

DECIMAL NUMBER 13

DECIMAL TO BINARY CONVERSION
(÷2 METHOD)


END
0
1
2
4
9
2
1
2
2
2
4
2
9
2
19
DECIMAL NUMBER
−0
−2
−4
−8
−18
1
0
0
1
1
REMAINDER
BINARY NUMBER

TR-911-225 △1

BINARY NUMBER TO DECIMAL NUMBER

7	6	5	4	3	2	1	POSITION
2^6	2^5	2^4	2^3	2^2	2^1	2^0	POWER OF 2 MULTIPLIER
64	32	16	8	4	2	1	POSITION DECIMAL VALUE
1	0	1	0	1	1	0	BINARY NUMBER
64	0	16	0	4	2	0	DECIMAL VALUES TO BE SUMMED
$64 + 16 + 4 + 2 = 86$							DECIMAL NUMBER EQUAL TO BINARY NUMBER

TR-911-226 △

[illegible]

[illegible]

[illegible]

BINARY WORD USAGE

PLRTY ±	64	32	16	8	4	2	1	DECIMAL VALUE
1	0	1	0	1	1	0	1	LOGIC STATE
⊓		⊓		⊓	⊓		⊓	PULSES FOR TRANSMISSION
B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	BITS

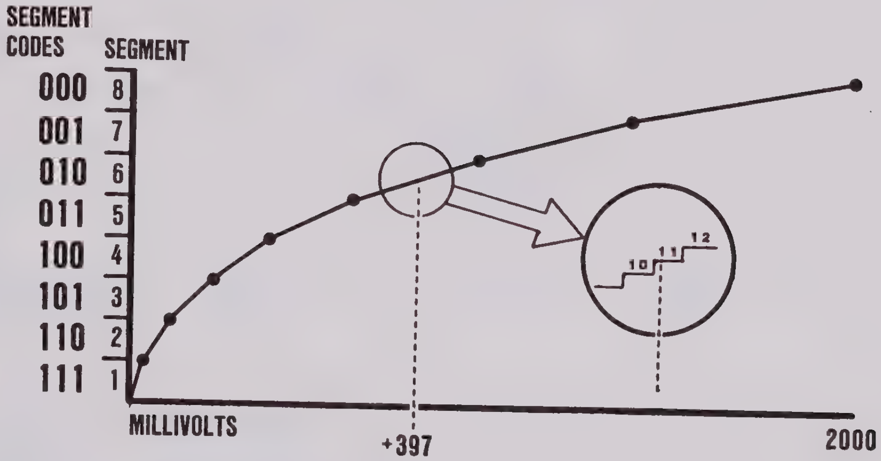
VH INFO 1-8

BINARY WORD

The Binary Word is used to encode a PAM sample of the Analog input for PCM transmission.

TR-911-227 △1

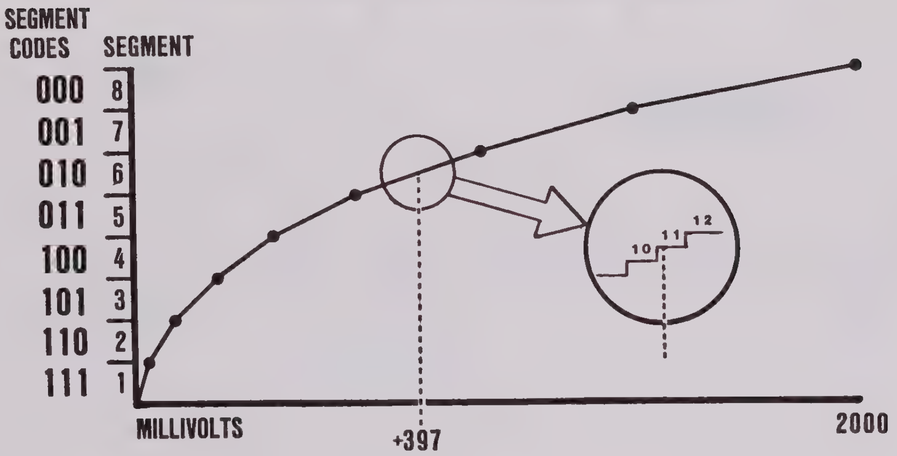
QUANTIZATION OF PAM SAMPLE VOLTAGE



POLARITY	1 = POS		0 = NEG
SEGMENT	111 = 1	TO	000 = 8
STEP	1111 = 1	TO	0000 = 16

QUANTIZING

DEVELOPING THE 8 BIT BINARY WORD



1. DETERMINE POLARITY POS=1 NEG=0 (POS) 1 _ _ _ _ _ _ _

2. DETERMINE SEGMENT YES=0 NO=1

IS THE VOLTAGE ABOVE SEGMENT 4 ? (YES) _ 0 _ _ _ _ _ _

ABOVE SEGMENT 6 ? (NO) _ _ 1 _ _ _ _ _

ABOVE SEGMENT 5 ? (YES) _ _ _ 0 _ _ _ _

3. DETERMINE STEP YES=0 NO=1

IS THE VOLTAGE ABOVE STEP 8 ? (YES) _ _ _ _ 0 _ _ _

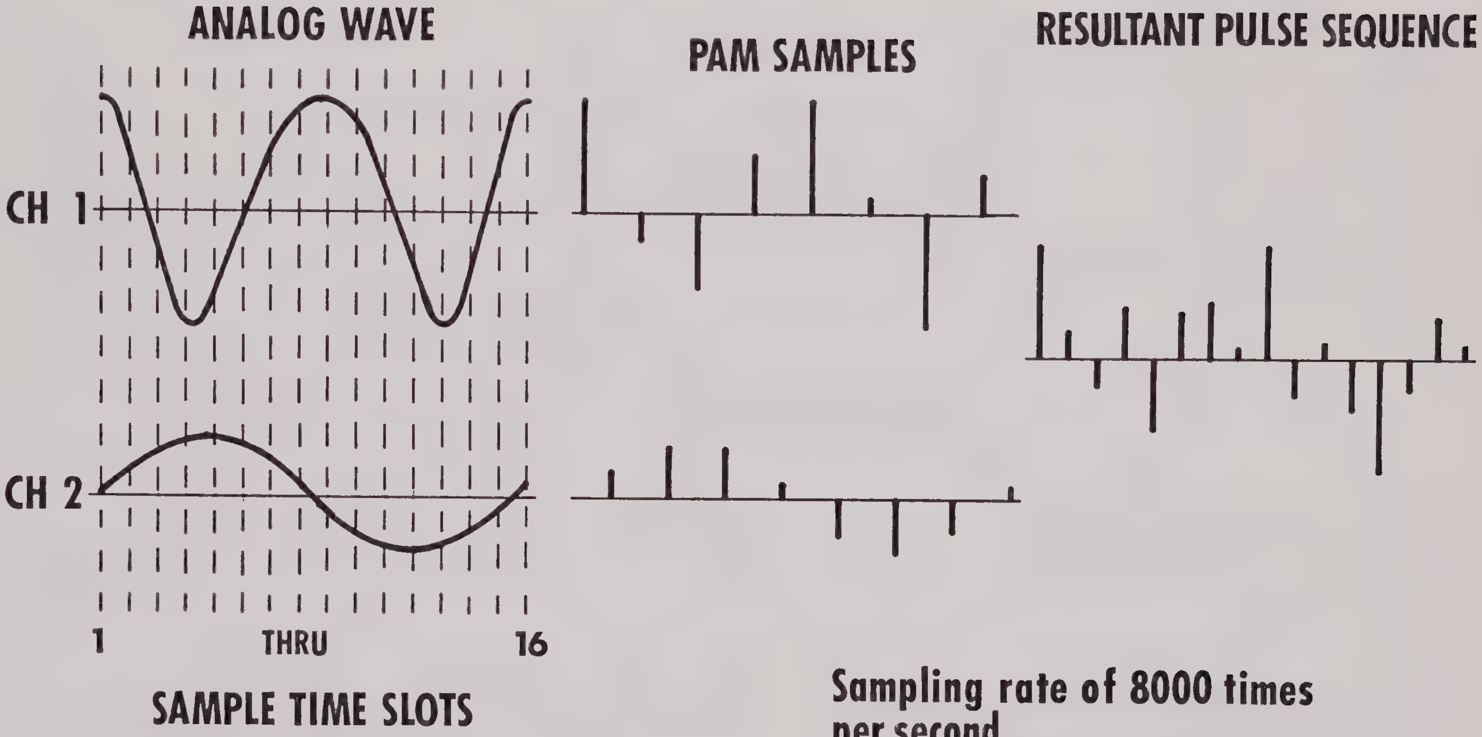
ABOVE STEP 12 ? (NO) _ _ _ _ _ 1 _ _

ABOVE STEP 10 ? (YES) _ _ _ _ _ _ 0 _

ABOVE STEP 11 ? (NO) _ _ _ _ _ _ _ 1

1 0 1 0 0 1 0 1

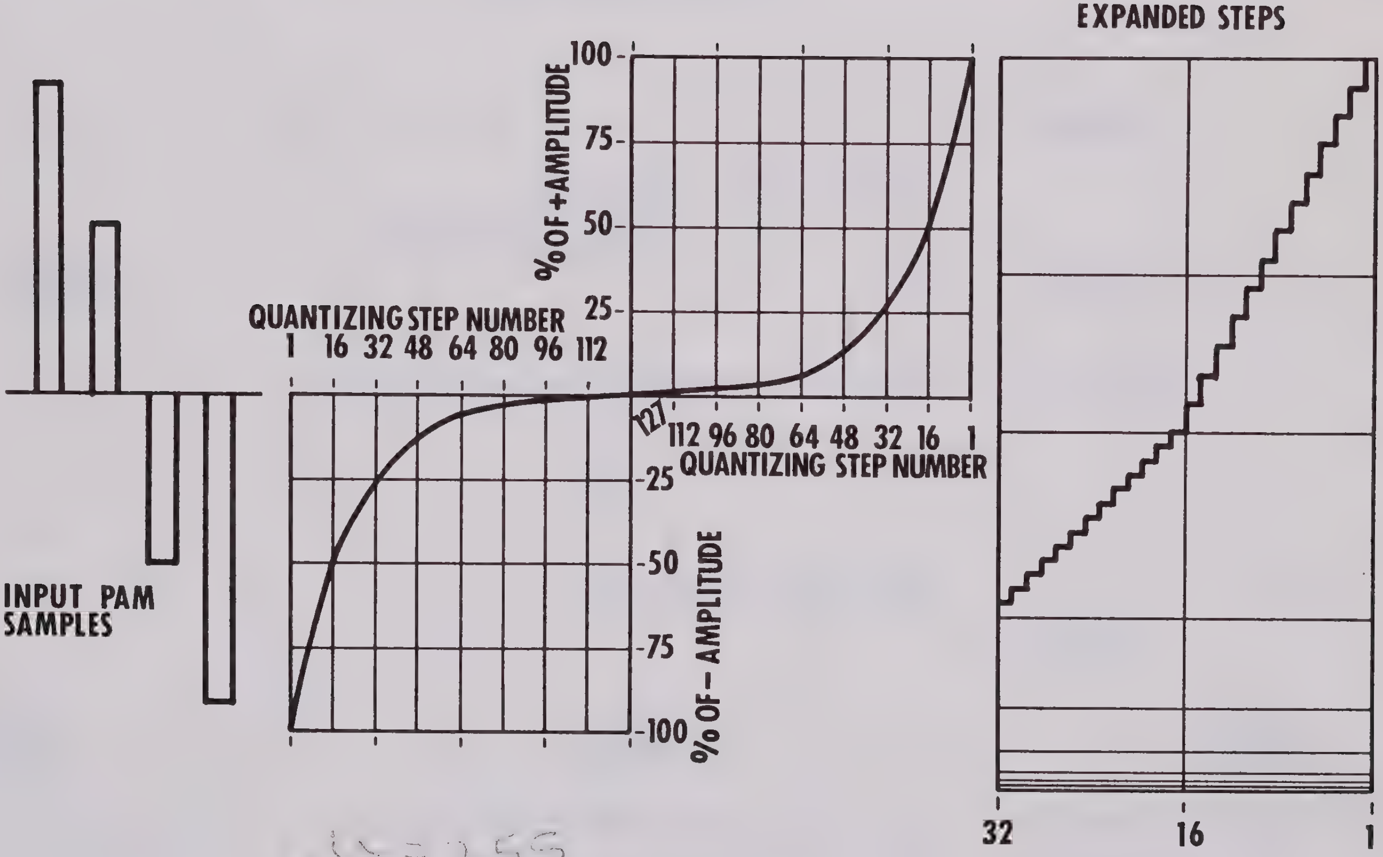
SAMPLING


ANALOG WAVE
PAM SAMPLES
RESULTANT PULSE SEQUENCE
CH 1
CH 2
1
THRU
16
SAMPLE TIME SLOTS

Sampling rate of 8000 times
per second.

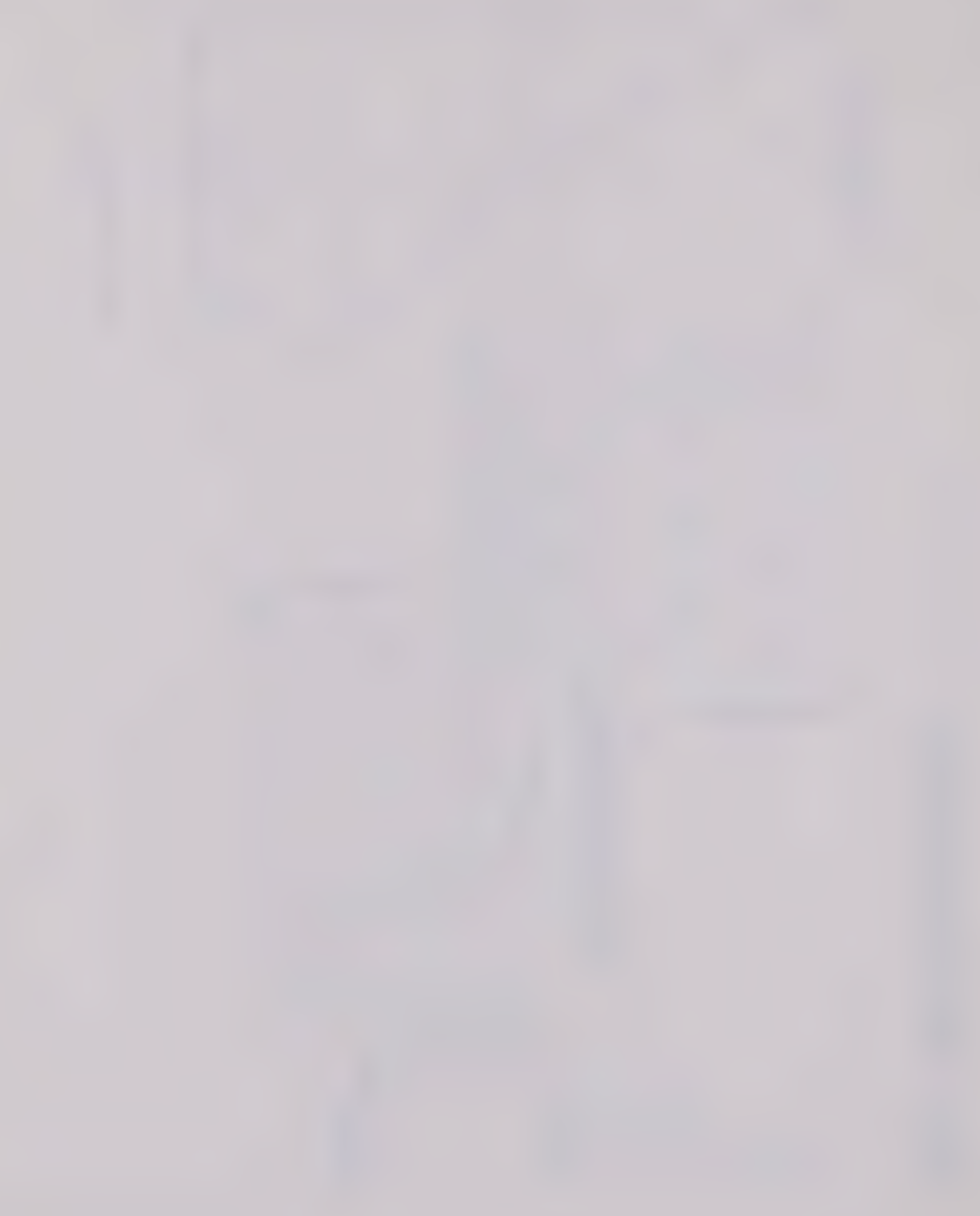
TR-911-248 △2

NON LINEAR QUANTIZING

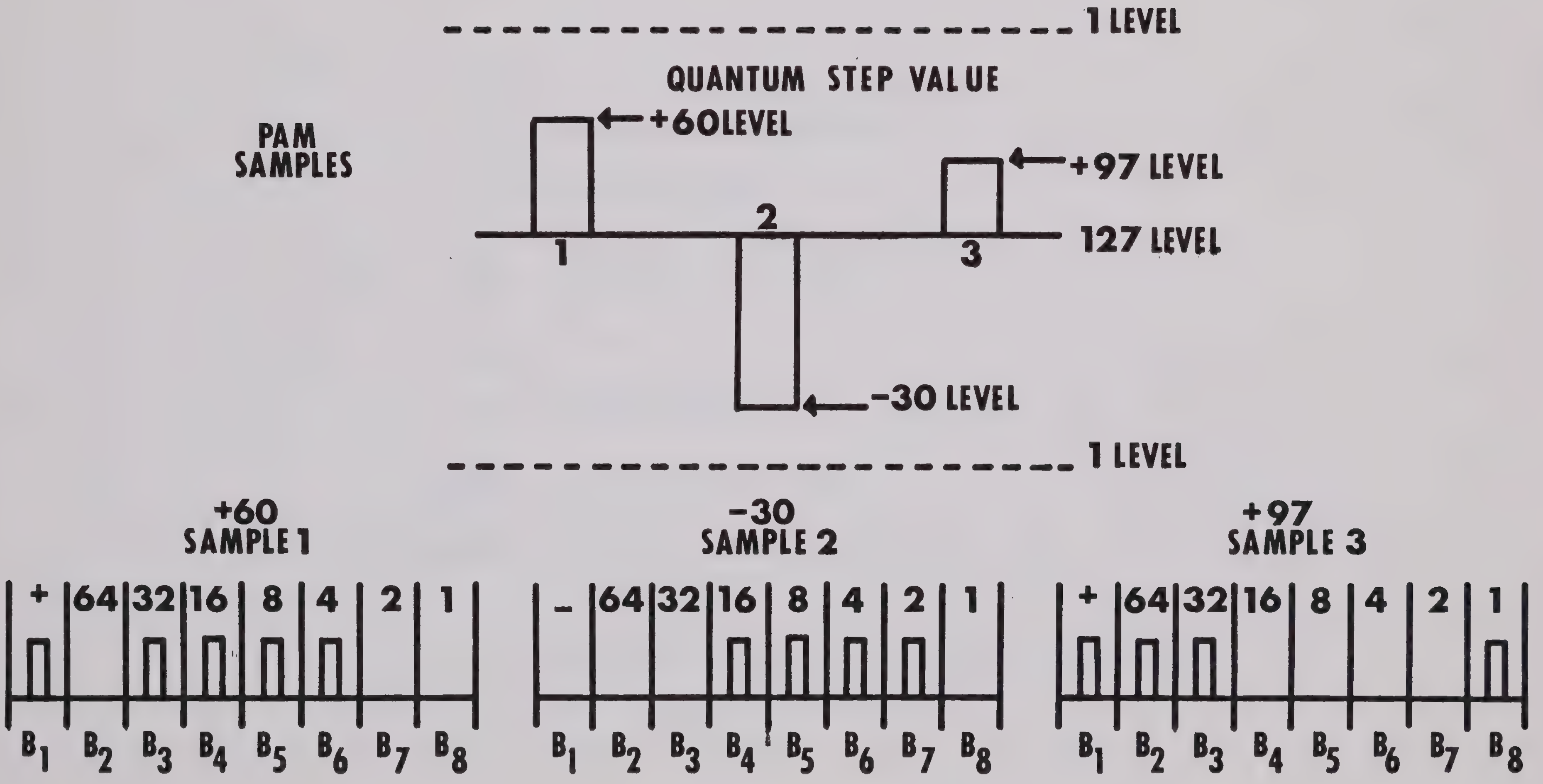


μ = 255

TR-911-249 △3



ENCODING


1 LEVEL
QUANTUM STEP VALUE
PAM
SAMPLES
+60LEVEL
+97 LEVEL
2
127 LEVEL
1
3
-30 LEVEL
1 LEVEL
+60
SAMPLE 1
-30
SAMPLE 2
+97
SAMPLE 3
+
64
32
16
8
4
2
1
B_1 B_2 B_3 B_4 B_5 B_6 B_7 B_8
–
64
32
16
8
4
2
1
B_1 B_2 B_3 B_4 B_5 B_6 B_7 B_8
+
64
32
16
8
4
2
1
B_1 B_2 B_3 B_4 B_5 B_6 B_7 B_8

TR-911-250 △1

T_1 LINE BIT RATE

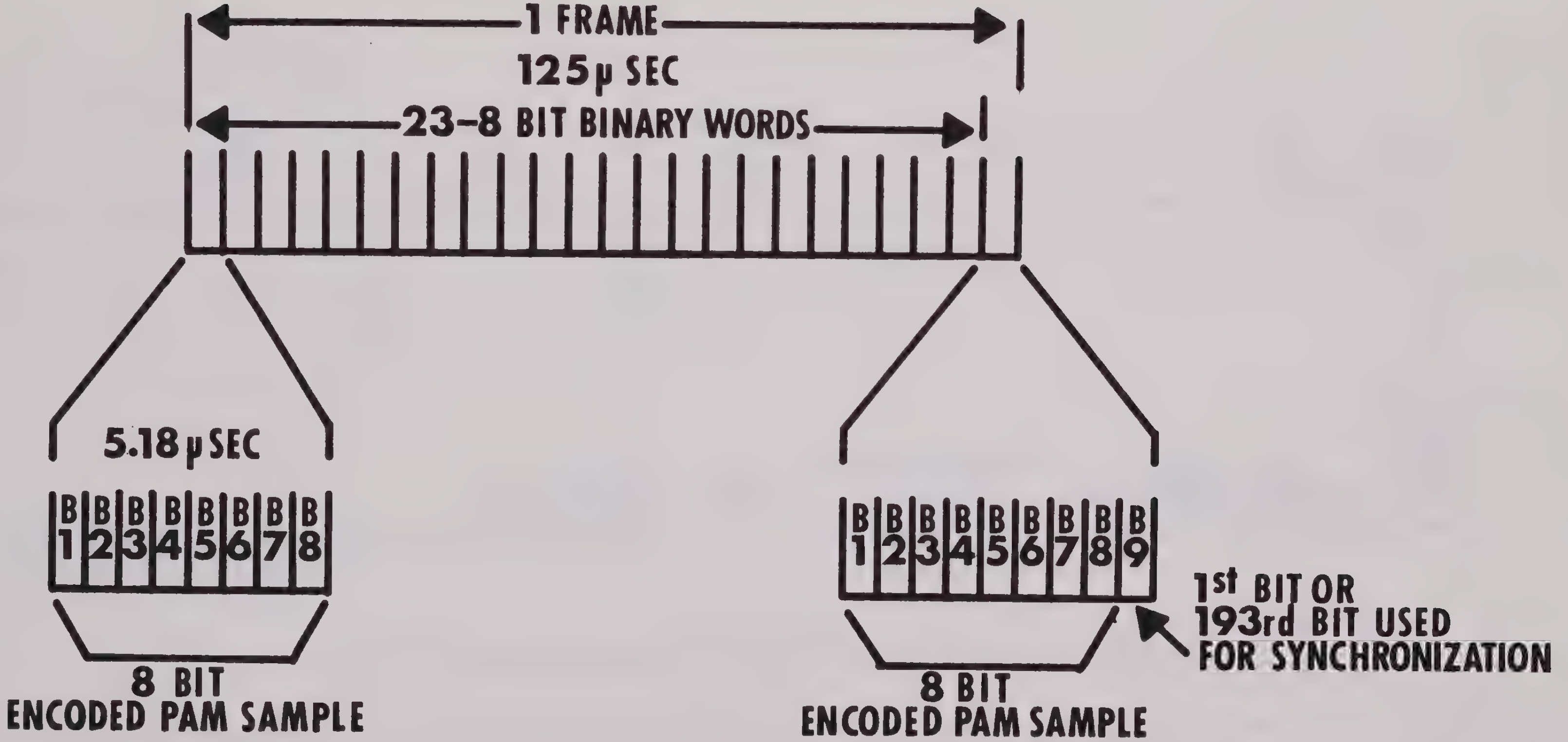
24	CHANNELS OR WORDS
X8	BITS PER WORD
192	"WORD BITS"/FRAME
+ 1	"S" BIT
193	BITS/FRAME
X8000	SAMPLING RATE/SEC
1,544,000	BITS/SEC = 1.544 MB/S = LINE BIT RATE

DIGITAL SIGNAL AT THE FIRST LEVEL (DS1)

T_1 LINE BIT RATE

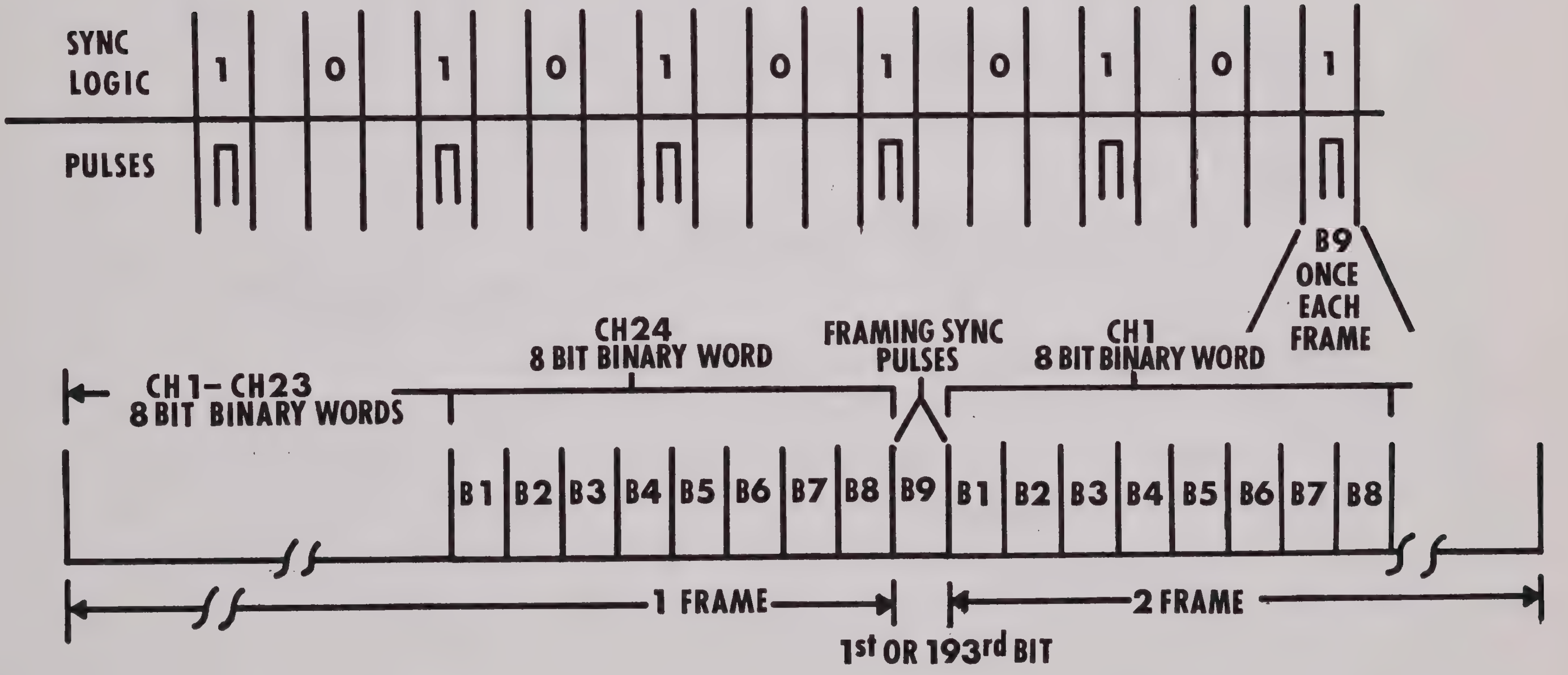
24	CHANNELS OR WORDS
X8	BITS PER WORD
192	"WORD BITS"/FRAME
+ 1	"S" BIT
193	BITS/FRAME
X8000	SAMPLING RATE/SEC
1,544,000	BITS/SEC = 1.544 MB/S = LINE BIT RATE
	DIGITAL SIGNAL AT THE FIRST LEVEL (DS1)

FRAME


1 FRAME
125μ SEC
23–8 BIT BINARY WORDS
5.18 μ SEC
B1 B2 B3 B4 B5 B6 B7 B8
8 BIT
ENCODED PAM SAMPLE
B1 B2 B3 B4 B5 B6 B7 B8 B9
1st BIT OR
193rd BIT USED
FOR SYNCHRONIZATION
8 BIT
ENCODED PAM SAMPLE

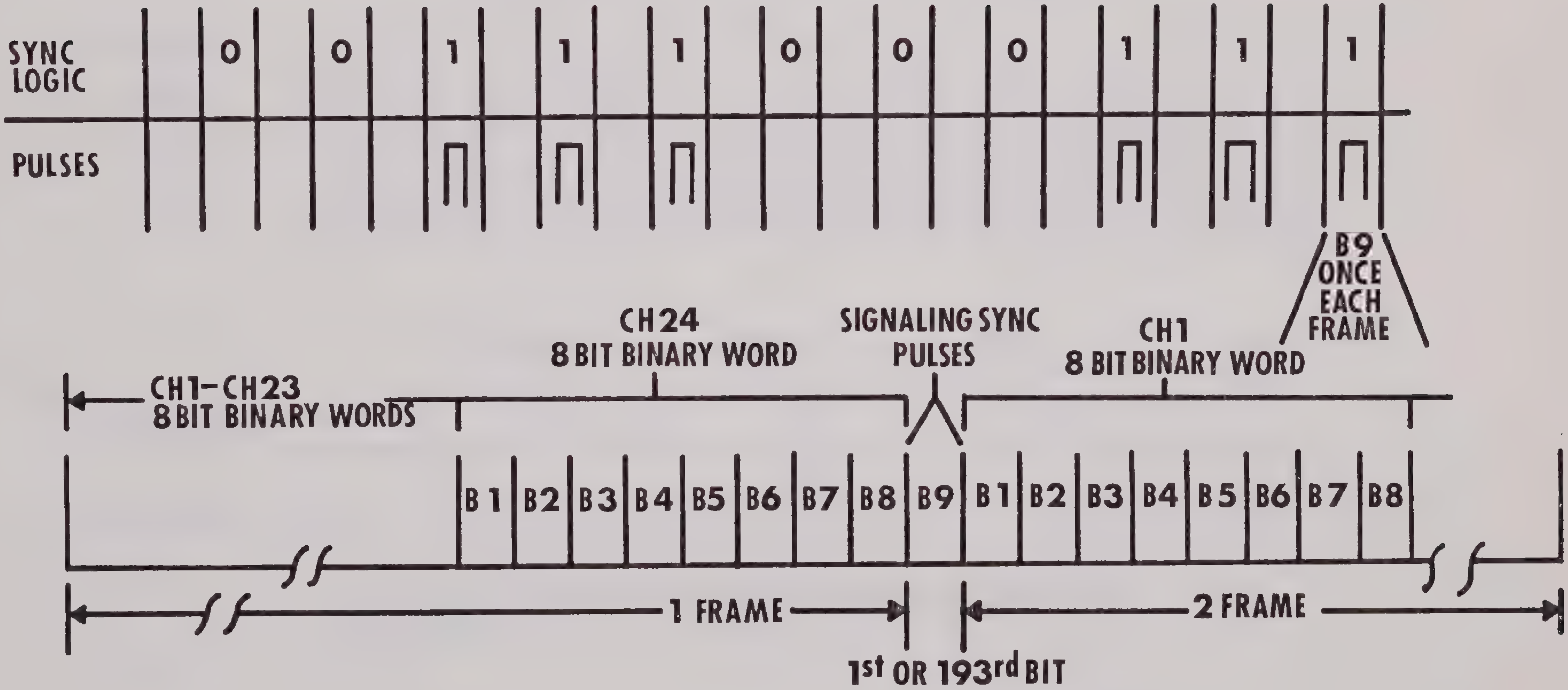
TR-911-252 △3

FRAMING SYNCHRONIZATION


SYNC LOGIC
PULSES
1
0
1
0
1
0
1
0
1
0
1
B9 ONCE EACH FRAME
CH1–CH23 8 BIT BINARY WORDS
CH24 8 BIT BINARY WORD
FRAMING SYNC PULSES
CH1 8 BIT BINARY WORD
B1
B2
B3
B4
B5
B6
B7
B8
B9
B1
B2
B3
B4
B5
B6
B7
B8
1 FRAME
2 FRAME
1st OR 193rd BIT

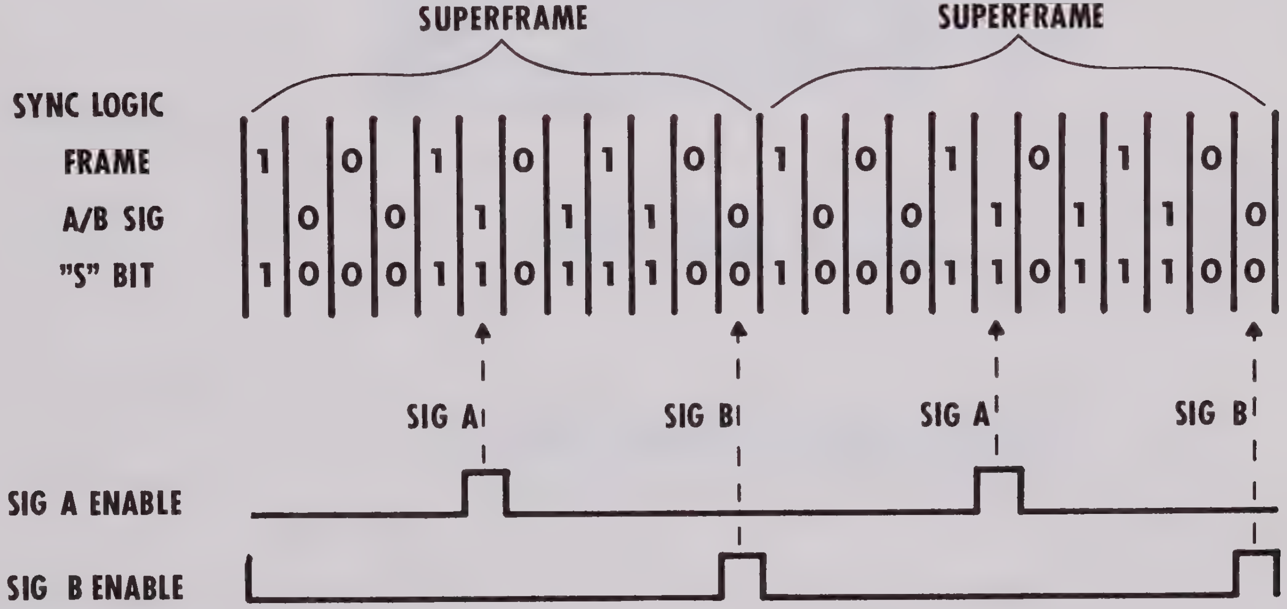
TR-911-253 △2

SIGNALING SYNCHRONIZATION


SYNC LOGIC
PULSES
0
0
1
1
1
0
0
0
1
1
1
B9 ONCE EACH FRAME
CH1-CH23
8 BIT BINARY WORDS
CH24
8 BIT BINARY WORD
SIGNALING SYNC PULSES
CH1
8 BIT BINARY WORD
B1
B2
B3
B4
B5
B6
B7
B8
B9
B1
B2
B3
B4
B5
B6
B7
B8
1 FRAME
2 FRAME
1st OR 193rd BIT

TR-911-254 △2

"S" BIT SYNC PATTERN


SUPERFRAME
SUPERFRAME
SYNC LOGIC
FRAME
1 0 1 0 1 0 1 0 1 0 1 0
A/B SIG
0 0 1 1 1 0 0 0 1 1 1 0
"S" BIT
1 0 0 0 1 1 0 1 1 1 0 0 1 0 0 0 1 1 0 1 1 1 0 0
SIG A
SIG B
SIG A
SIG B
SIG A ENABLE
SIG B ENABLE

SIGNALING TRANSMITTED FOR ALL CHANNELS DURING EVERY 6th FRAME.

TR-911-255 △4

DIAL PULSE SIGNALING

SIGNALING
TRANSMITTED EACH
6th FRAME

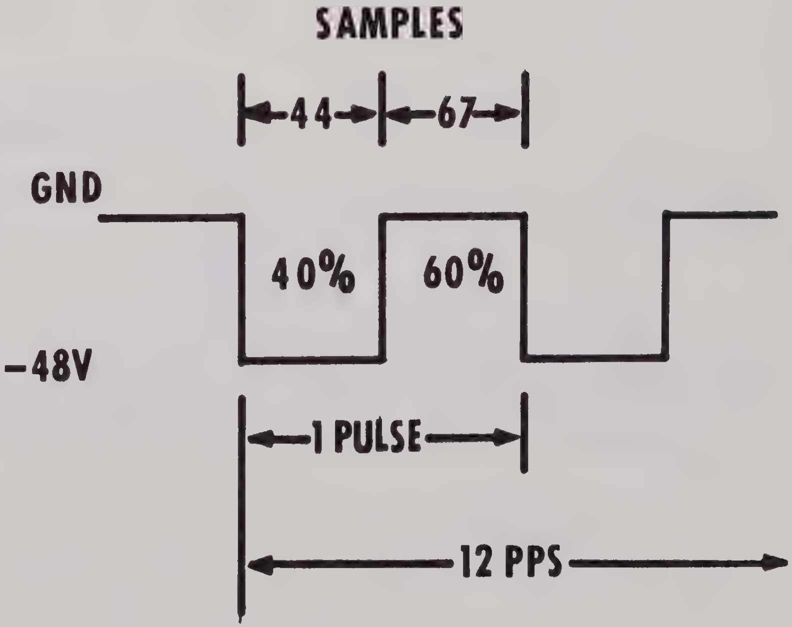
$\frac{\text{1333 SAMPLES/SEC}}{\text{8000 FRAMES/SEC}}$

DIAL PULSE STD

12 PPS AT 60% BREAK

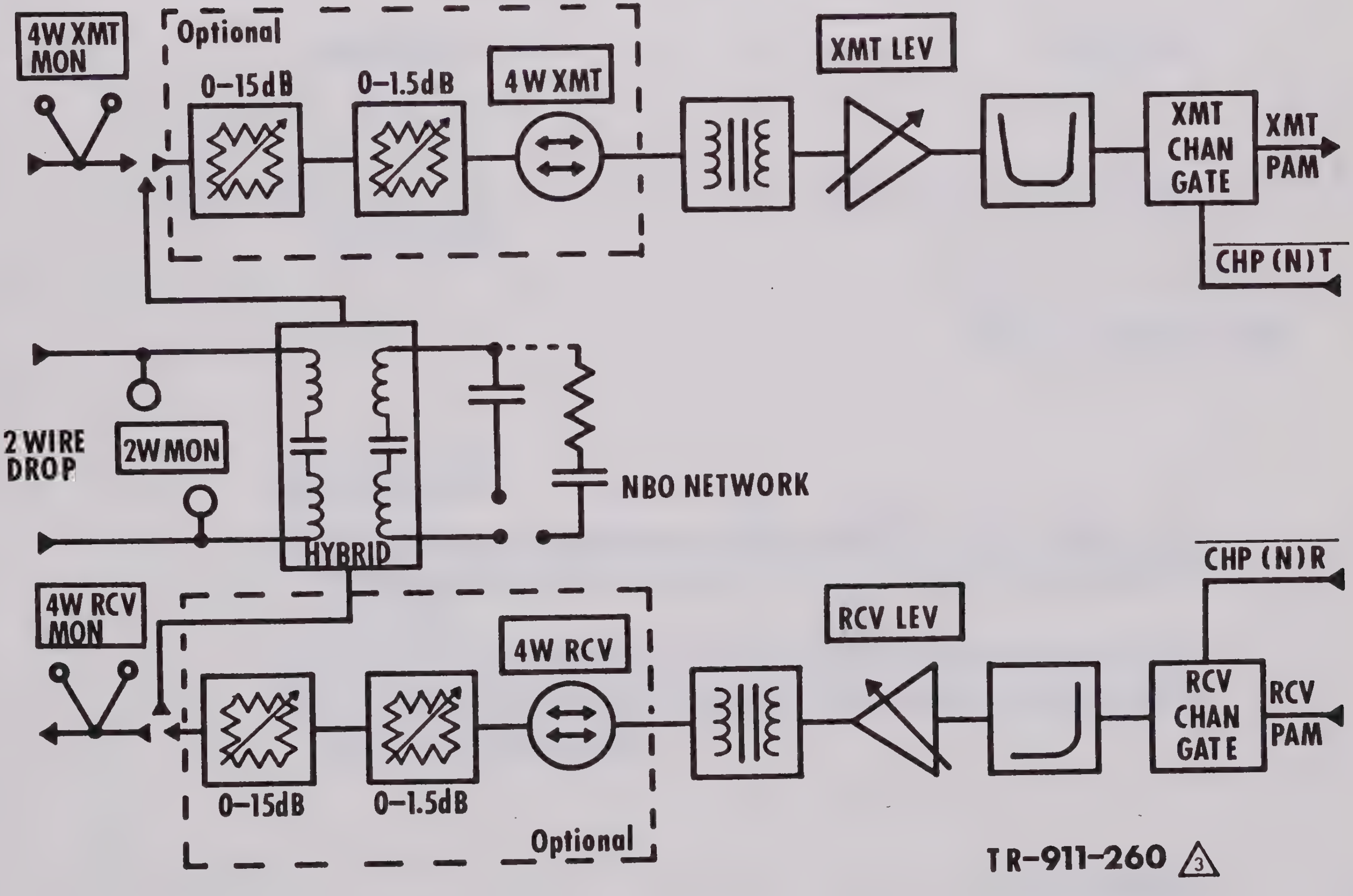
12 PPS

$\frac{\text{111 SAMPLES/PULSE}}{\text{1333 SAMPLES/SEC}}$


SAMPLES
44
67
GND
40%
60%
-48V
1 PULSE
12 PPS

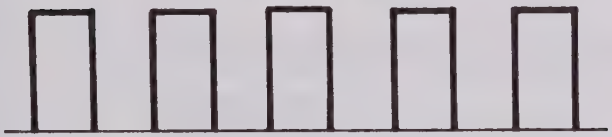
TR-911-257 △3

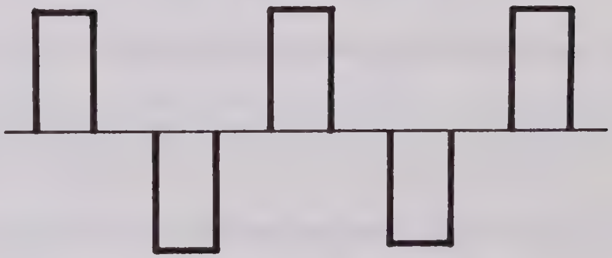
CHANNEL UNIT VF PATH


4W XMT MON
Optional
0–15dB
0–1.5dB
4W XMT
XMT LEV
XMT CHAN GATE
XMT PAM
CHP (N)T
2 WIRE DROP
2W MON
HYBRID
NBO NETWORK
4W RCV MON
4W RCV
RCV LEV
RCV CHAN GATE
RCV PAM
CHP (N)R
0–15dB
0–1.5dB
Optional

TR–911–260 △3

BIPOLAR ADVANTAGES


UNIPOLAR
1.544 MB/S


BIPOLAR
772 KHz EQUIVALENT

ADVANTAGES:

1. The energy concentrates at one half of the pulse rate frequency resulting in lower attenuation through cable facility.
2. Transformer coupling made easier and less expensive.
3. Violations of the alternating pulse pattern may be used for error detection.

91230 OPERATIONAL INPUTS & OUTPUTS

LEAD DESIGN	CHARACTERISTICS	FUNCTION
PCM-T′ Input Pin 32	Unipolar transmit PCM, negative logic pulses 150 ± 10 ns in duration.	Becomes receive PCM input to REC common unit when terminal is looped by pushing loop button during ALM condition.
CHP-12T′ Input Pin 20	3.240 µ Sec. pulse at logic level from XMT channel counter.	During looped terminal conditions becomes FR EN for XMT digit generator. Establishes a 12 channel offset for loop testing.
CHP-24T′ Input Pin 22	3.240 µ Sec. pulse at logic level from XMT channel counter.	Becomes frame enable for XMIT digit generator under normal conditions.
SYNC Input Pin 23	Positive going logic level pulse at D8 time of CHP-24R, 324 ns.	Inverted in alarm card and passed on to alignment test set for synchronizing its digital section. (Framing in test set must start 1 count early due to delays in its circuitry.)
CP-R Input Pin 27	1.544 MHz square wave at logic level.	Inverted in alarm card and passed on to alignment test set for generating digit and channel pulses in the digital section.
FR-EN Output Pin 34	3.240 µ sec. pulse at logic level (CHP)	Enables D9 from transmit digit generator at the end of CHP-24T during normal conditions and at the end of CHP-12T during looped conditions.

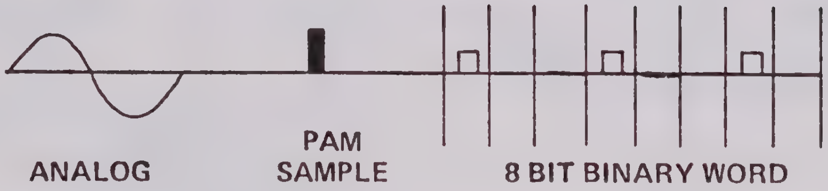
91230 ALARM INPUTS & OUTPUTS (ALL LOGIC LEVELS: 0 = LOW .4V MAX 1 = HIGH 2.4V MIN)

LEAD DESIGN	NORMAL	ALARM
AC-1 Local Alarm Input Pin 40	In-frame condition: 2 KHz logic level square wave from Rec out-of-frame detector.	1. Out-of-frame: Random freq., logic level square wave with periods greater than .5 ms. 2. Loss of RCV signal: D.C. input either logic high or low.
AC-2 Remote Alarm Input Pin 39	Randomly occuring 5.18 µ sec. negative logic pulses (One for each bit 2 received).	D.C. logic 1 level (Approx. +5V).
PWR Fail 1) +5V Pin 19 2) +12V Pin 42 3) -12V Pin 44 Input	1) +5V DC 2) +12V DC 3) -12V DC	1) Less than 2V DC 2) Less than 4.5V DC 3) Less than 9V DC
AC-4´ (Bit 2 Inhibit Output) Pin 38	Logic level 1	1) Local Alarm: Logic 0 2) Power Alarm: Logic 0 3) Remote Alarm: Logic 0 for 15 sec. maximum after alarm initiated.

91230 ALARM INPUTS & OUTPUTS (Continued)

LEAD DESIGN	NORMAL	ALARM
TP´ Output Pin 29	Time Pulse: Negative (logic 0) Pulse from logic 1. 60 m sec duration every 13 sec.	Single neg pulse of 40 ms released 10 sec after SA initiated, then no more pulses until alarm clears. (Condition "NO PULSES" enables CPFR logic in dial originating channel units.)
TMB´ Output Pin 31	Open circuit	Ground (Enables make-busy relay in channel units.)
AC-5´ Output Pin 24	Open circuit	Ground (Forces XMT common unit to send continuous one's when terminal looped.)
AC-6´ Output Pin 35	Logic level 1 (enables RCS)	Logic level 0 (Inhibits RCS during alarm condition.)
AC-7´ Pin 30	Logic 1 (+5V)	Ground (To enable internal clock during system alarm when system is operated off of looped clock.)

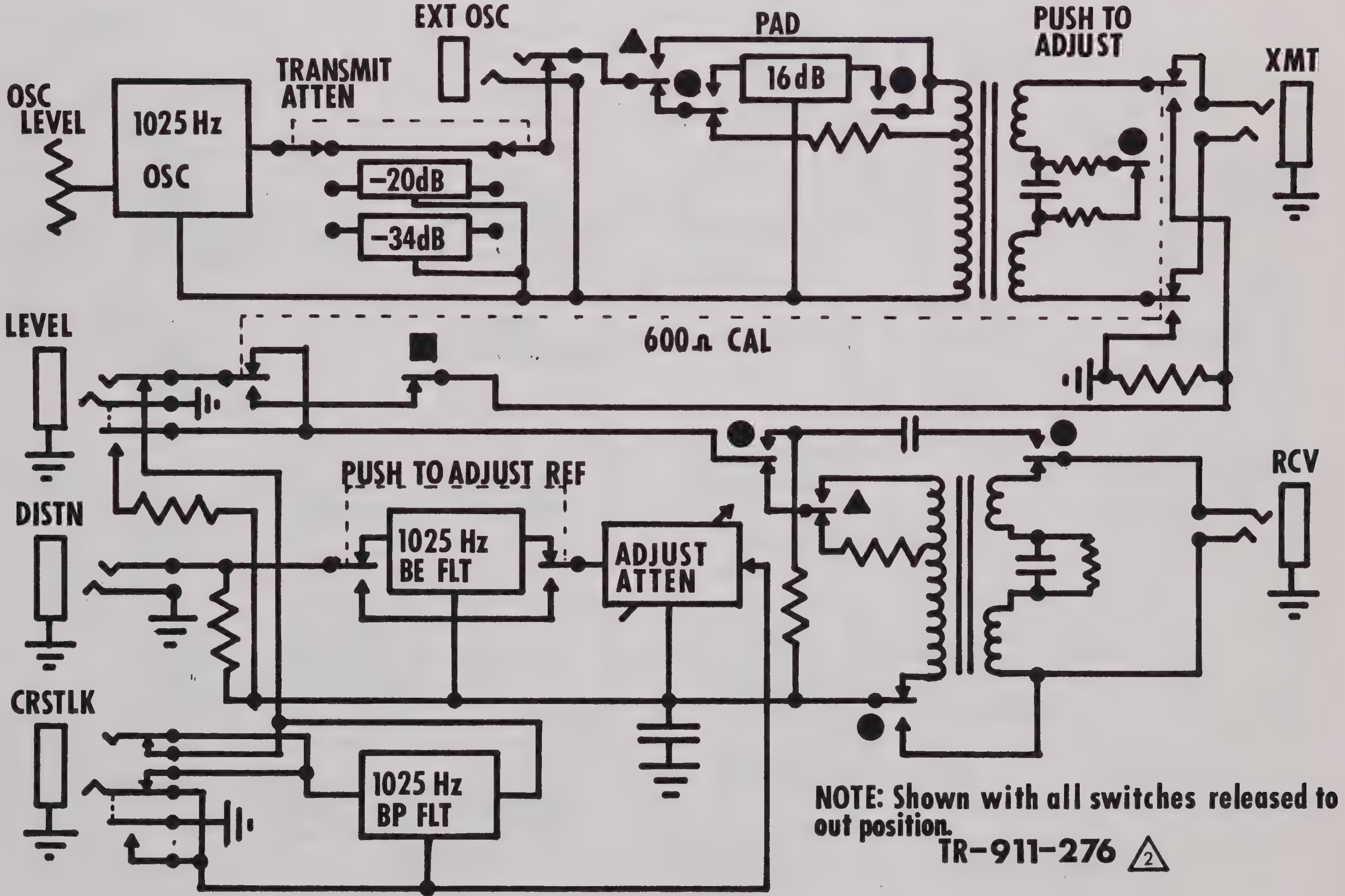
DIGITAL HIERARCHY



8 Bit Binary Word X 24 Channels plus 1 Sync Bit X 8000 Times Per Second = 1.544 Megabits Per Second = DS - 1

VOICE CHANNELS	(BELL) (SYSTEM)					
24	T1	=	DS-1	=	Digital Signal at the First Level	= 1.544 Mbps
48	T1C	=	DS-1C	=	Digital Signal at an Intermediate Level	= 3.152 Mbps
96	T2	=	DS-2	=	Digital Signal at the Second Level	= 6.312 Mbps
672	T3	=	DS-3	=	Digital Signal at the Third Level	= 44.736 Mbps
4032	T4	=	DS-4	=	Digital Signal at the Fourth Level	= 274.175 Mbps

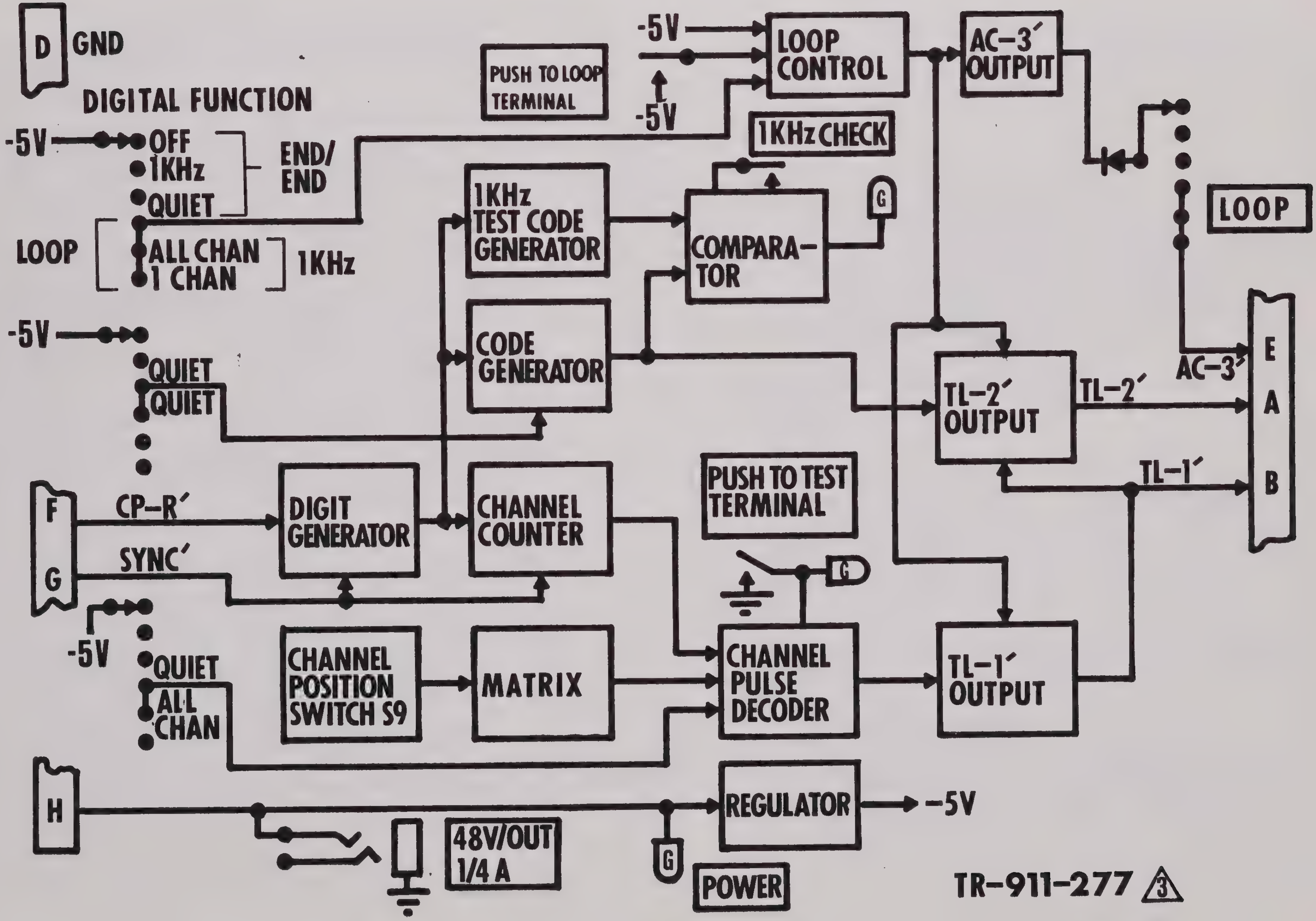
91232 TEST SET, ANALOG SECTION


EXT OSC
PAD
PUSH TO ADJUST
XMT
TRANSMIT ATTEN
OSC LEVEL
1025 Hz OSC
16dB
−20dB
−34dB
600Ω CAL
LEVEL
PUSH TO ADJUST REF
1025 Hz BE FLT
ADJUST ATTEN
RCV
DISTN
CRSTLK
1025 Hz BP FLT
2

NOTE: Shown with all switches released to out position.

TR-911-276

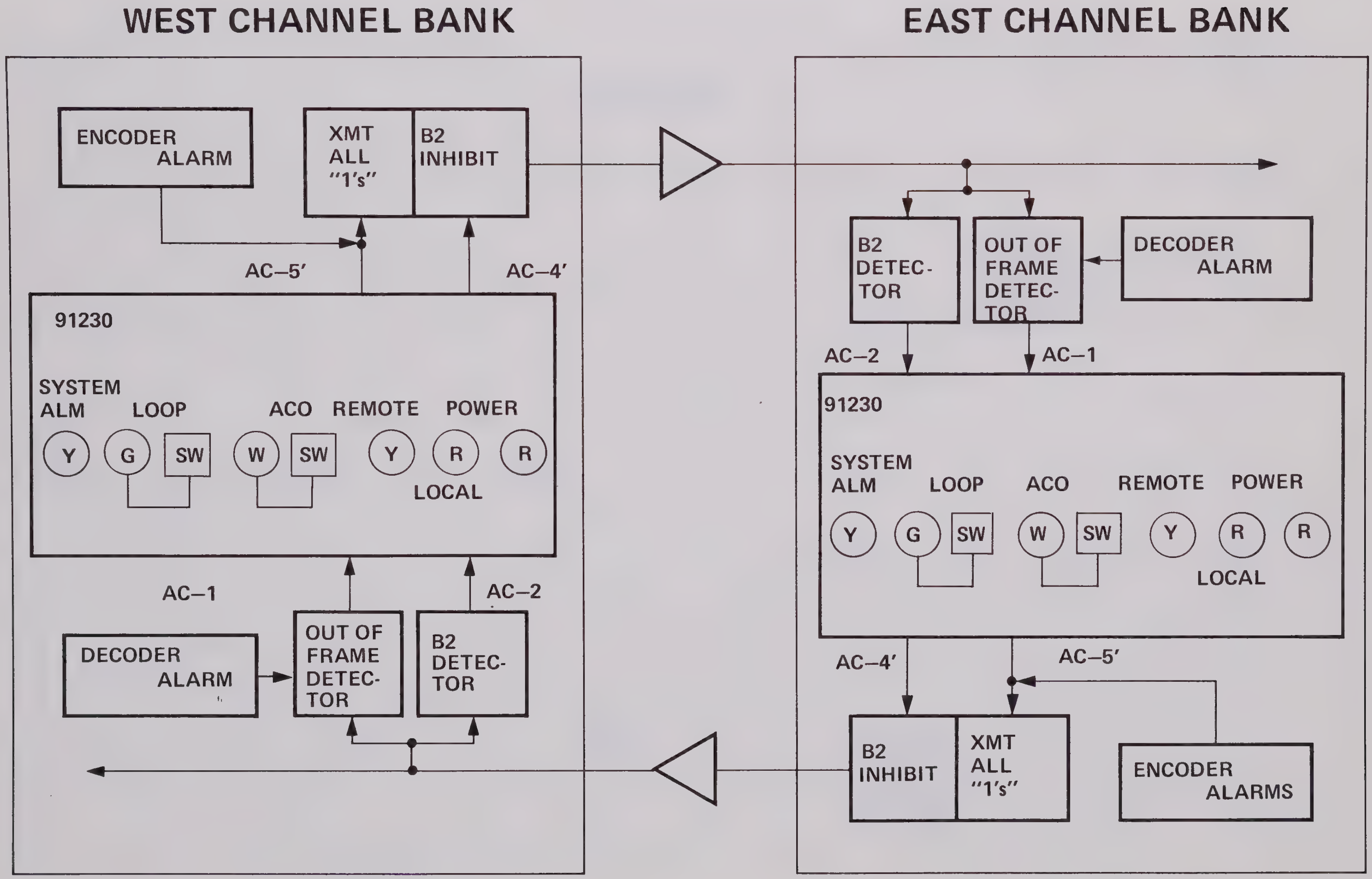
91232 TEST SET, DIGITAL SECTION


D
GND
DIGITAL FUNCTION
-5V
OFF
1KHz
QUIET
END/ END
LOOP
ALL CHAN
1 CHAN
1KHz
PUSH TO LOOP TERMINAL
-5V
-5V
LOOP CONTROL
AC-3′ OUTPUT
1KHz CHECK
1KHz TEST CODE GENERATOR
COMPARA-TOR
G
LOOP
-5V
QUIET
QUIET
CODE GENERATOR
TL-2′ OUTPUT
AC-3′
E
TL-2′
A
TL-1′
B
F
CP-R′
G
SYNC′
DIGIT GENERATOR
CHANNEL COUNTER
PUSH TO TEST TERMINAL
G
-5V
QUIET
ALL CHAN
CHANNEL POSITION SWITCH S9
MATRIX
CHANNEL PULSE DECODER
TL-1′ OUTPUT
H
REGULATOR
-5V
48V/OUT 1/4 A
G
POWER

TR-911-277 △3

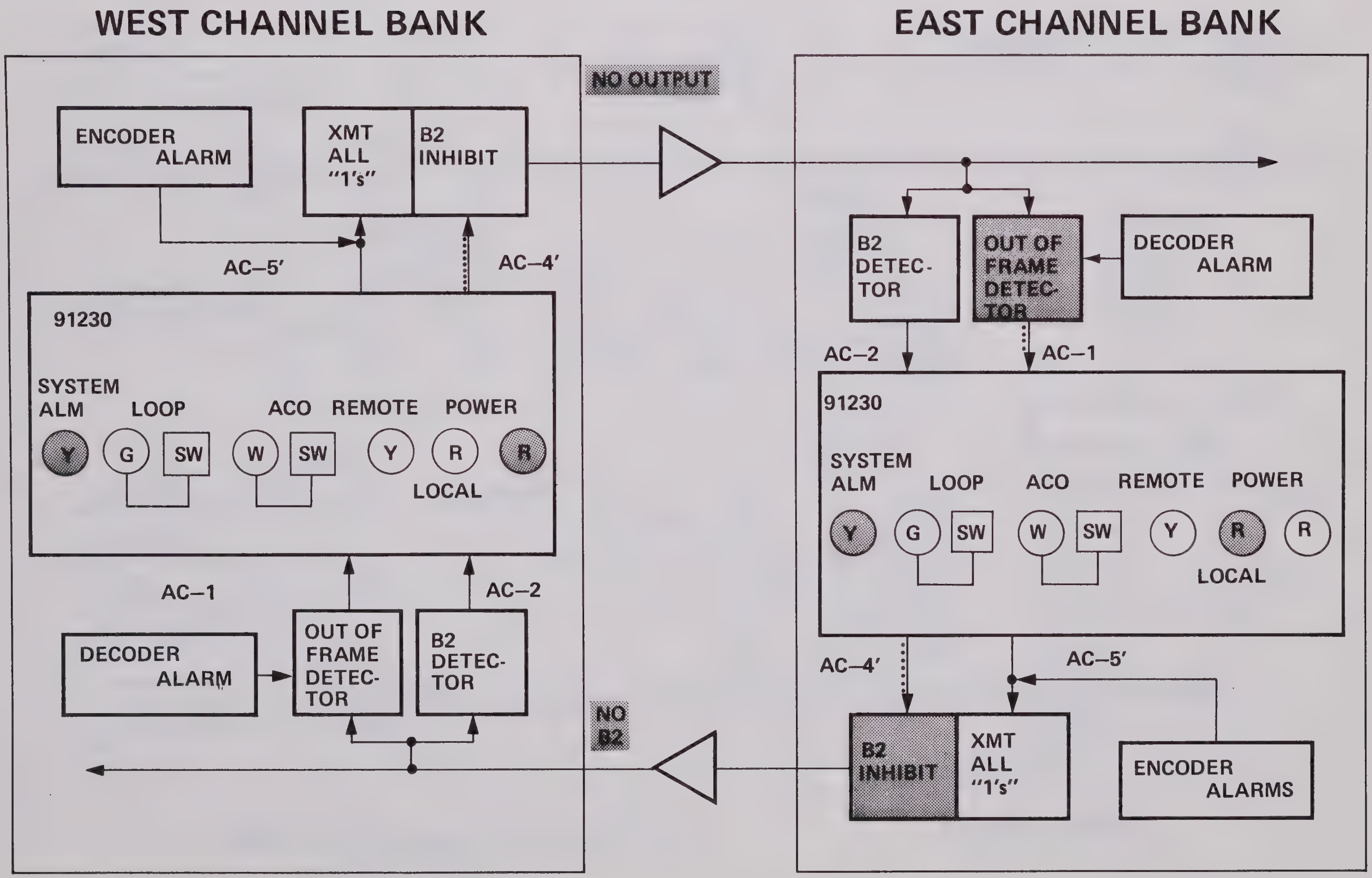
9002B SYSTEM ALARMS

SYSTEM NORMAL

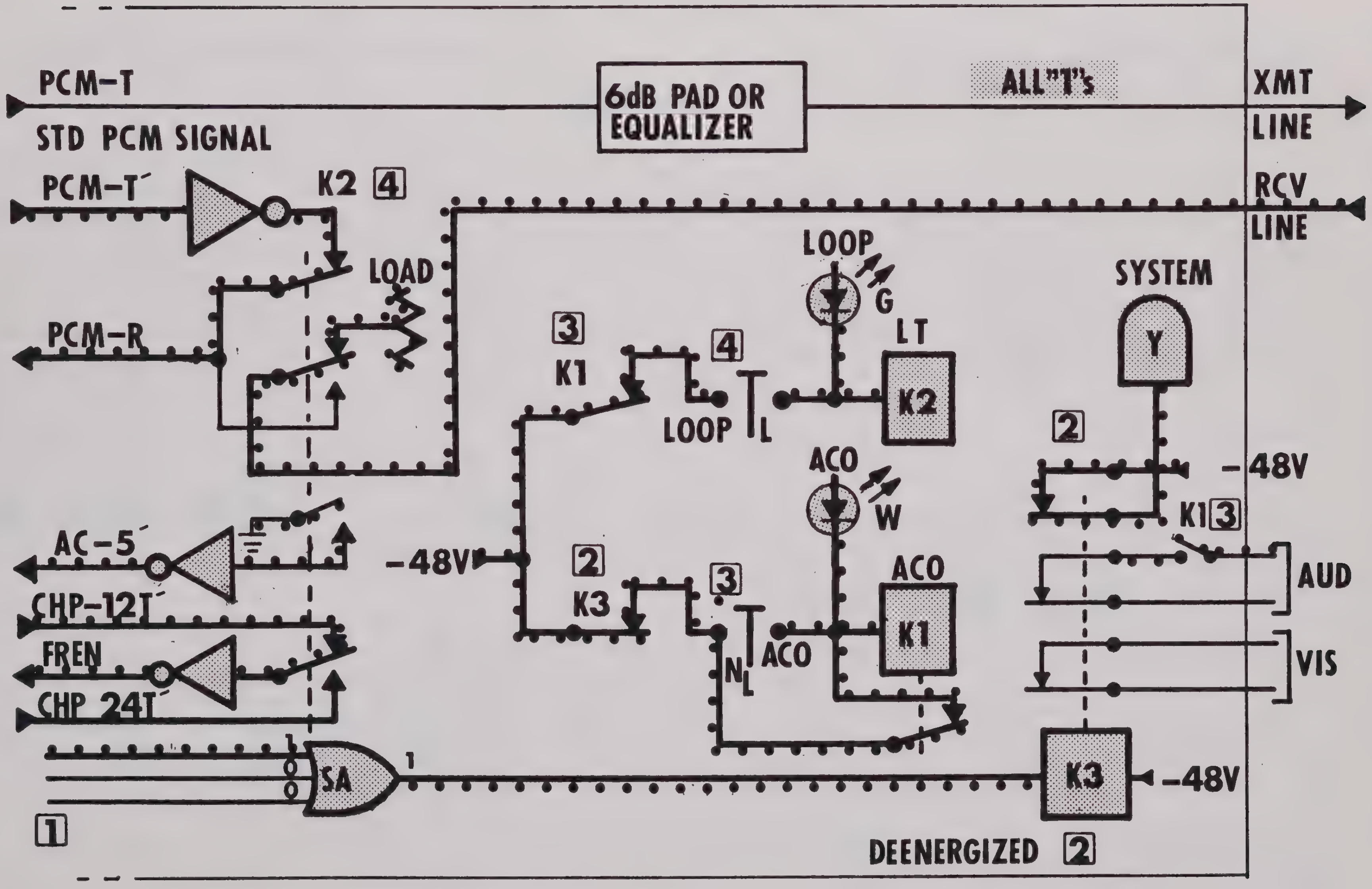

WEST CHANNEL BANK
EAST CHANNEL BANK
ENCODER ALARM
XMT ALL "1's"
B2 INHIBIT
AC–5′
AC–4′
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–1
AC–2
DECODER ALARM
OUT OF FRAME DETECTOR
B2 DETECTOR
B2 DETECTOR
OUT OF FRAME DETECTOR
DECODER ALARM
AC–2
AC–1
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–4′
AC–5′
B2 INHIBIT
XMT ALL "1's"
ENCODER ALARMS

9002B SYSTEM ALARMS

POWER FAILURE—WEST


WEST CHANNEL BANK
EAST CHANNEL BANK
NO OUTPUT
ENCODER ALARM
XMT ALL "1's"
B2 INHIBIT
AC–5′
AC–4′
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–1
AC–2
DECODER ALARM
OUT OF FRAME DETECTOR
B2 DETECTOR
NO B2
B2 DETECTOR
OUT OF FRAME DETECTOR
DECODER ALARM
AC–2
AC–1
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–4′
AC–5′
B2 INHIBIT
XMT ALL "1's"
ENCODER ALARMS

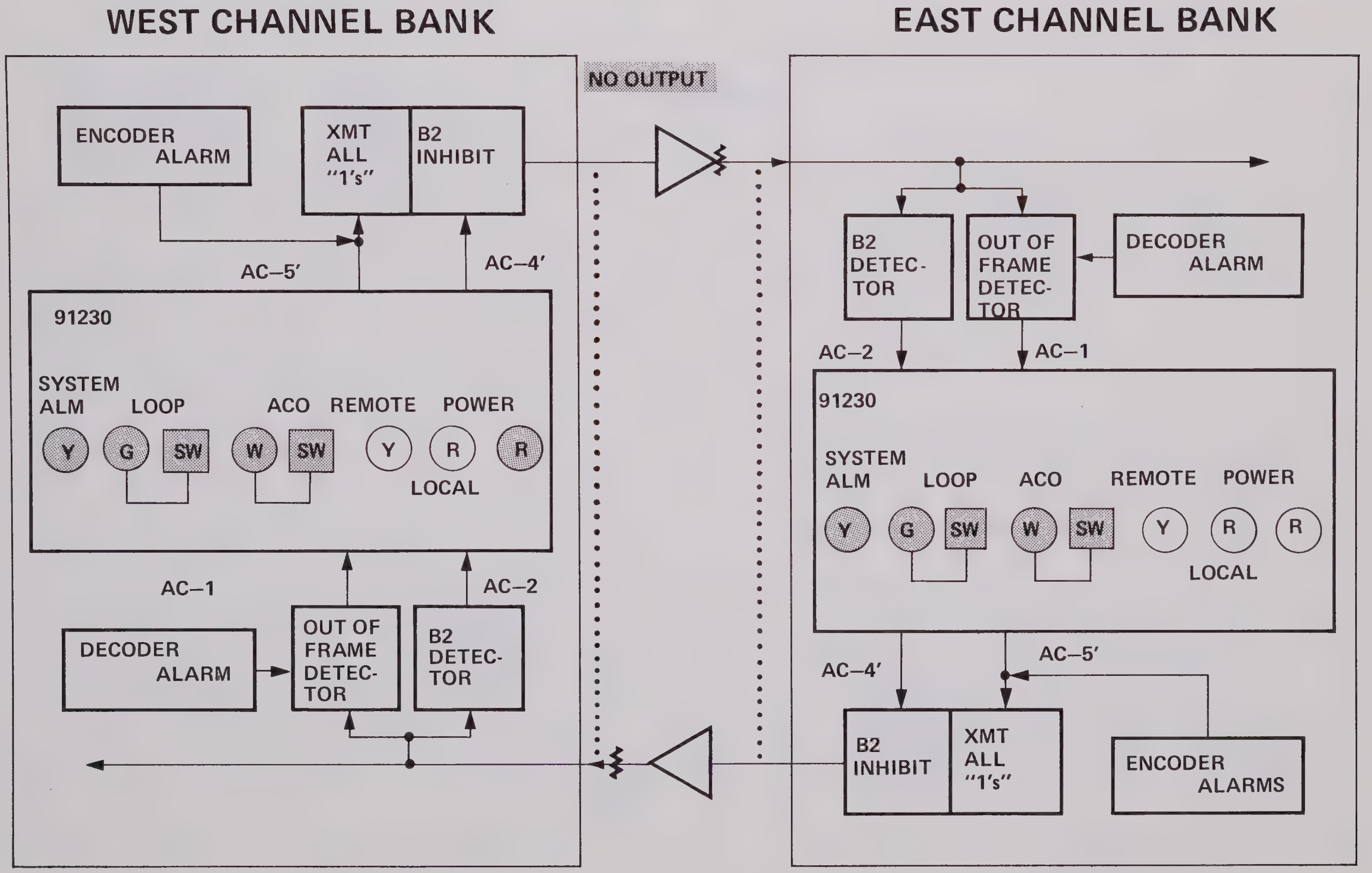
9002B LOOPING ACTION


PCM-T
6dB PAD OR EQUALIZER
ALL "1"'s
XMT LINE
STD PCM SIGNAL
PCM-T´
K2 4
RCV LINE
LOAD
PCM-R
LOOP
G
LT
SYSTEM
Y
3
K1
4
LOOP
L
K2
2
-48V
ACO
W
K1 3
AC-5´
-48V
2
K3
3
AUD
ACO
CHP-12T´
FREN
N
L
ACO
K1
VIS
CHP 24T´
1
1
0
0
SA
1
K3
-48V
1
DEENERGIZED 2

NOTE: Action steps are in order of the numbers in boxes

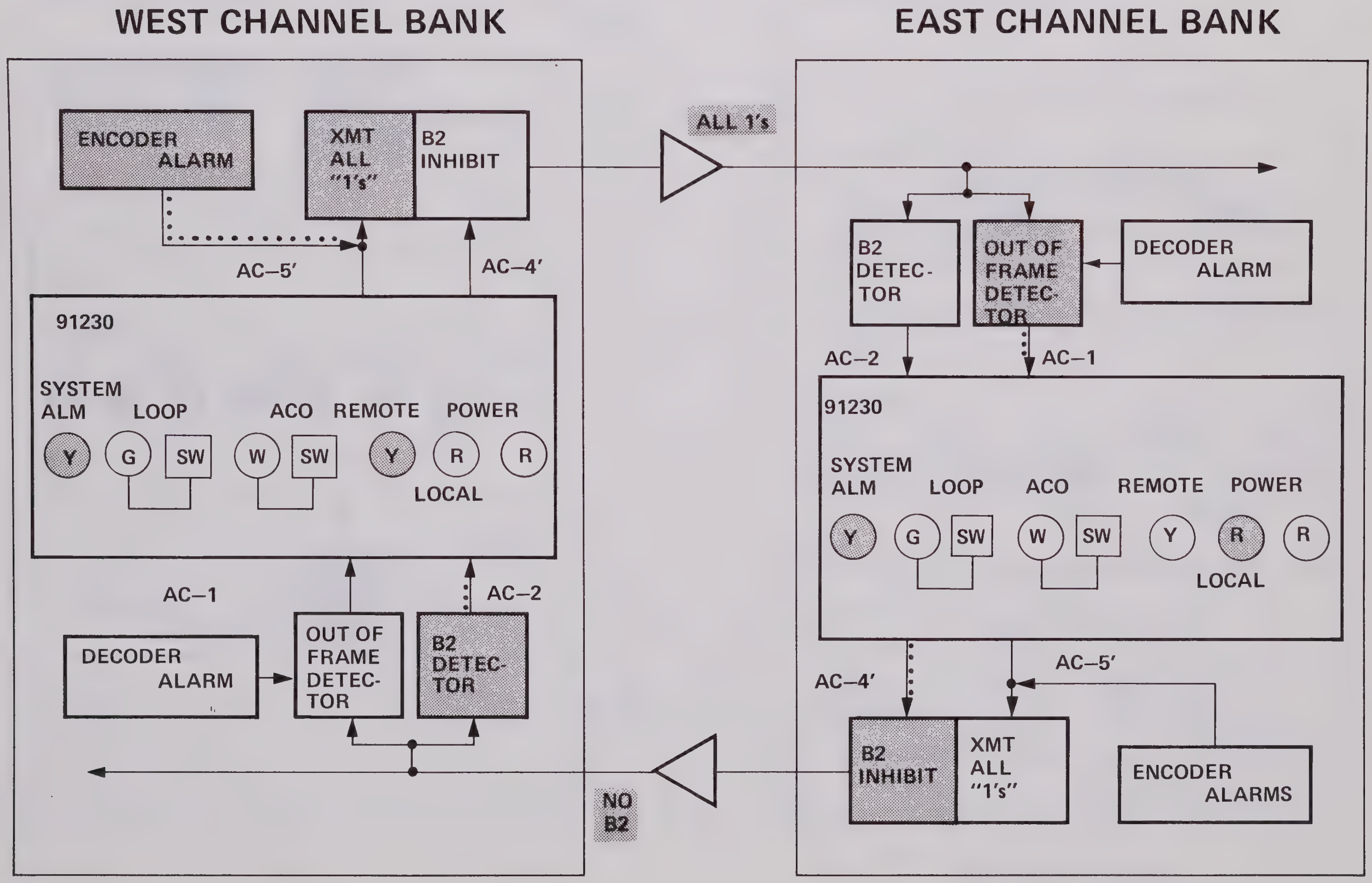
TR-911-305 △3

9002B SYSTEM ALARMS POWER FAILURE TERMS LOOPED

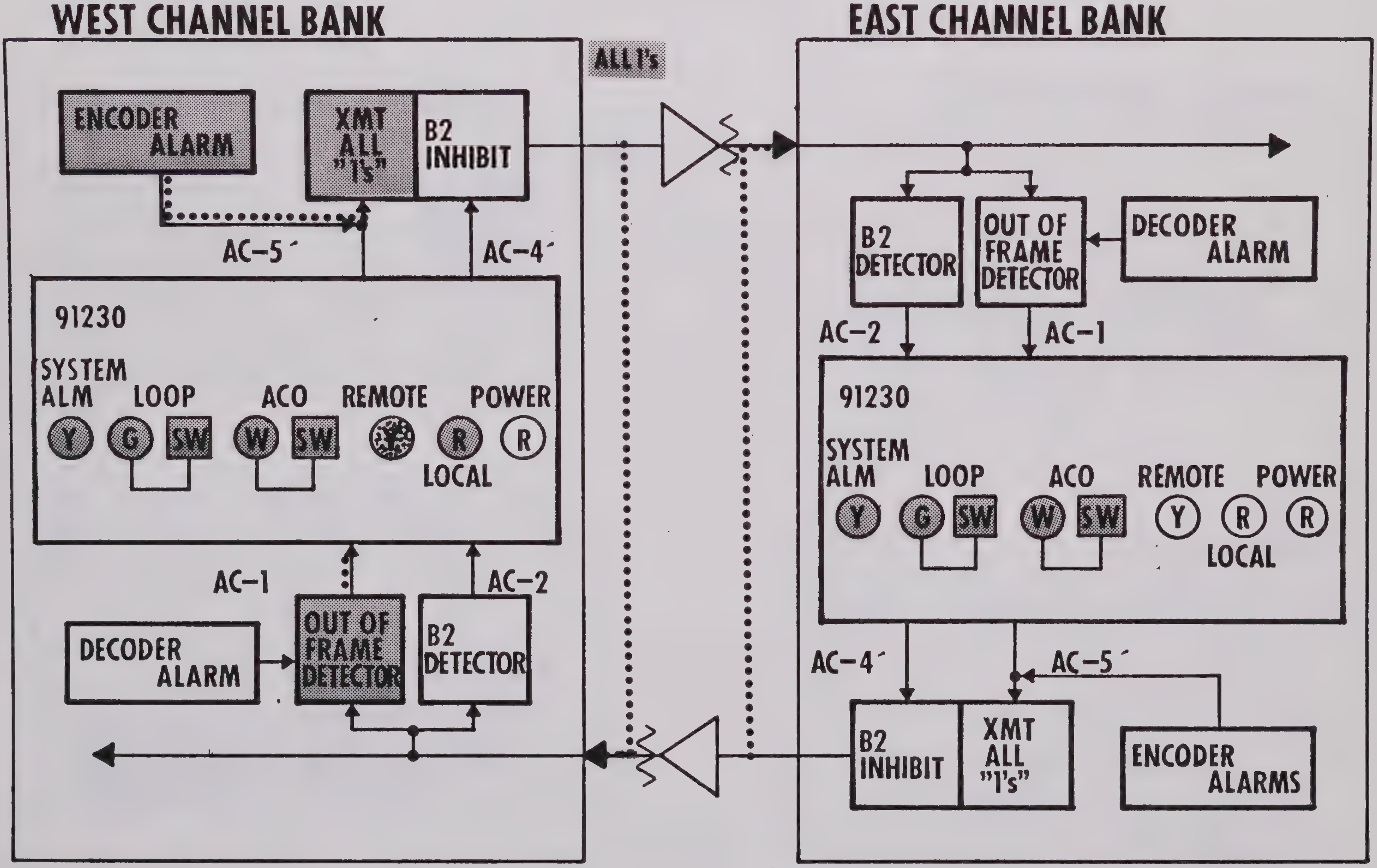

WEST CHANNEL BANK
EAST CHANNEL BANK
NO OUTPUT
ENCODER ALARM
XMT ALL "1's"
B2 INHIBIT
AC–5′
AC–4′
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–1
AC–2
DECODER ALARM
OUT OF FRAME DETECTOR
B2 DETECTOR
B2 DETECTOR
OUT OF FRAME DETECTOR
DECODER ALARM
AC–2
AC–1
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–4′
AC–5′
B2 INHIBIT
XMT ALL "1's"
ENCODER ALARMS

TR–911–306 △3

9002B SYSTEM ALARMS ENCODER FAILURE—WEST

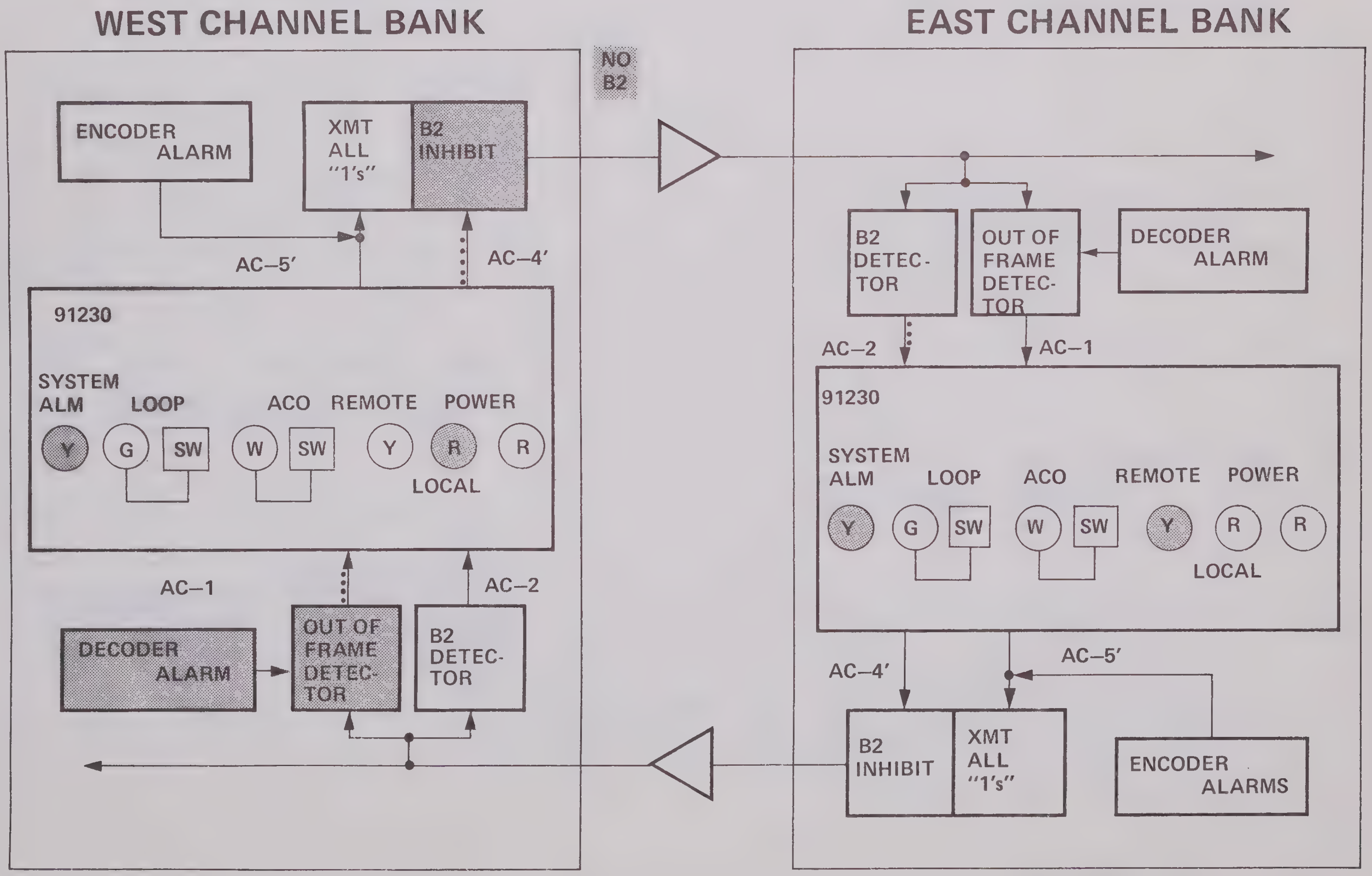

WEST CHANNEL BANK
EAST CHANNEL BANK
ENCODER ALARM
XMT ALL "1's"
B2 INHIBIT
AC–5′
AC–4′
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–1
AC–2
DECODER ALARM
OUT OF FRAME DETECTOR
B2 DETECTOR
ALL 1's
NO B2
B2 DETECTOR
OUT OF FRAME DETECTOR
DECODER ALARM
AC–2
AC–1
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–4′
AC–5′
B2 INHIBIT
XMT ALL "1's"
ENCODER ALARMS

9002B SYSTEM ALARMS ENCODER FAILURE—TERMS LOOPED

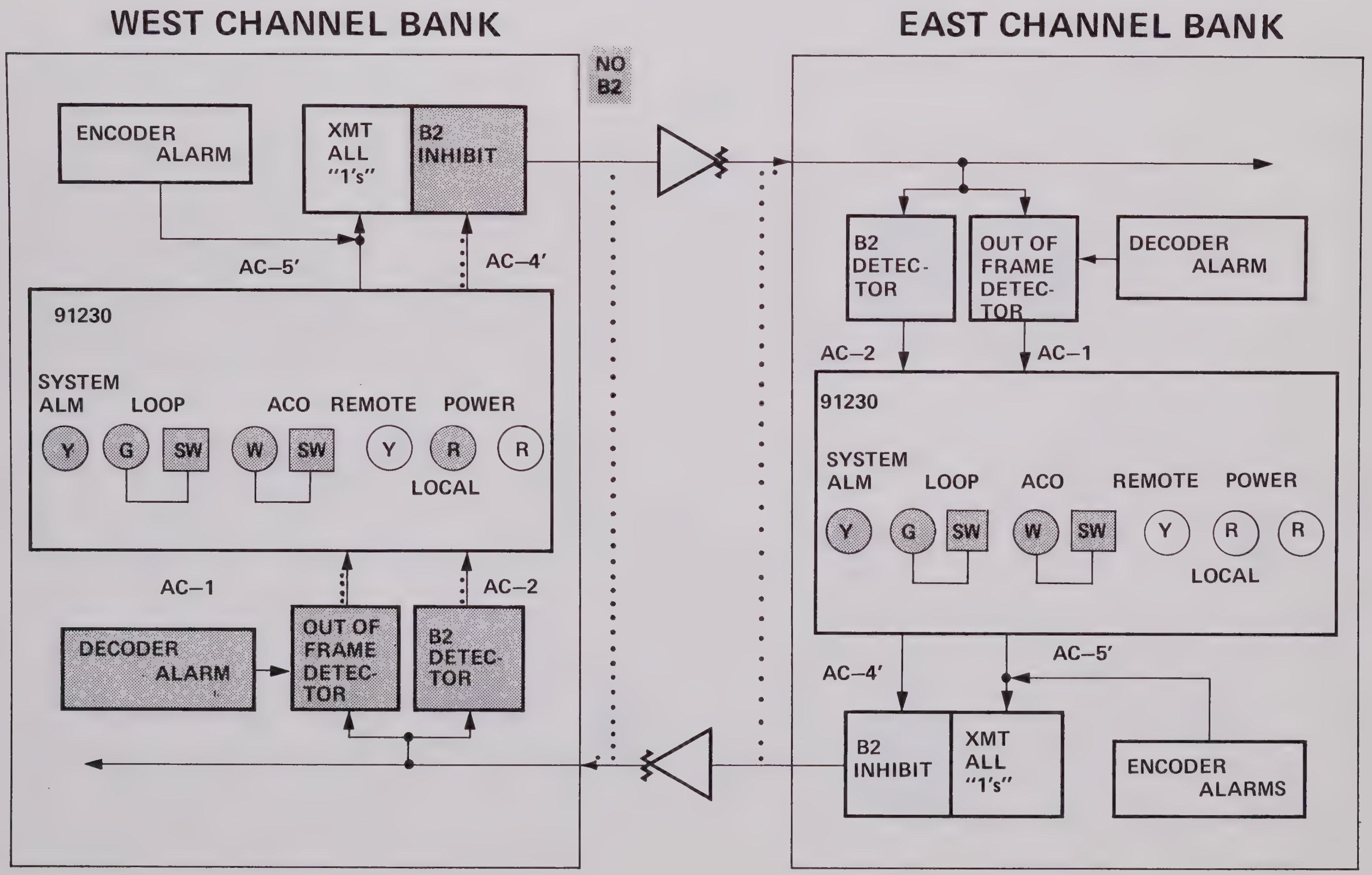

WEST CHANNEL BANK
EAST CHANNEL BANK
ALL 1's
ENCODER ALARM
XMT ALL "1's"
B2 INHIBIT
AC–5´
AC–4´
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
R
R
LOCAL
AC–1
AC–2
DECODER ALARM
OUT OF FRAME DETECTOR
B2 DETECTOR
B2 DETECTOR
OUT OF FRAME DETECTOR
DECODER ALARM
AC–2
AC–1
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–4´
AC–5´
B2 INHIBIT
XMT ALL "1's"
ENCODER ALARMS

9002B SYSTEM ALARMS

DECODER FAILURE—WEST


WEST CHANNEL BANK
EAST CHANNEL BANK
NO B2
ENCODER ALARM
XMT ALL "1's"
B2 INHIBIT
AC–5′
AC–4′
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–1
AC–2
DECODER ALARM
OUT OF FRAME DETECTOR
B2 DETECTOR
B2 DETECTOR
OUT OF FRAME DETECTOR
DECODER ALARM
AC–2
AC–1
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–4′
AC–5′
B2 INHIBIT
XMT ALL "1's"
ENCODER ALARMS

9002B SYSTEM ALARMS DECODER FAILURE—TERMS LOOPED


WEST CHANNEL BANK
EAST CHANNEL BANK
NO B2
ENCODER ALARM
XMT ALL "1's"
B2 INHIBIT
AC–5′
AC–4′
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–1
AC–2
DECODER ALARM
OUT OF FRAME DETECTOR
B2 DETECTOR
B2 DETECTOR
OUT OF FRAME DETECTOR
DECODER ALARM
AC–2
AC–1
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–5′
AC–4′
B2 INHIBIT
XMT ALL "1's"
ENCODER ALARMS

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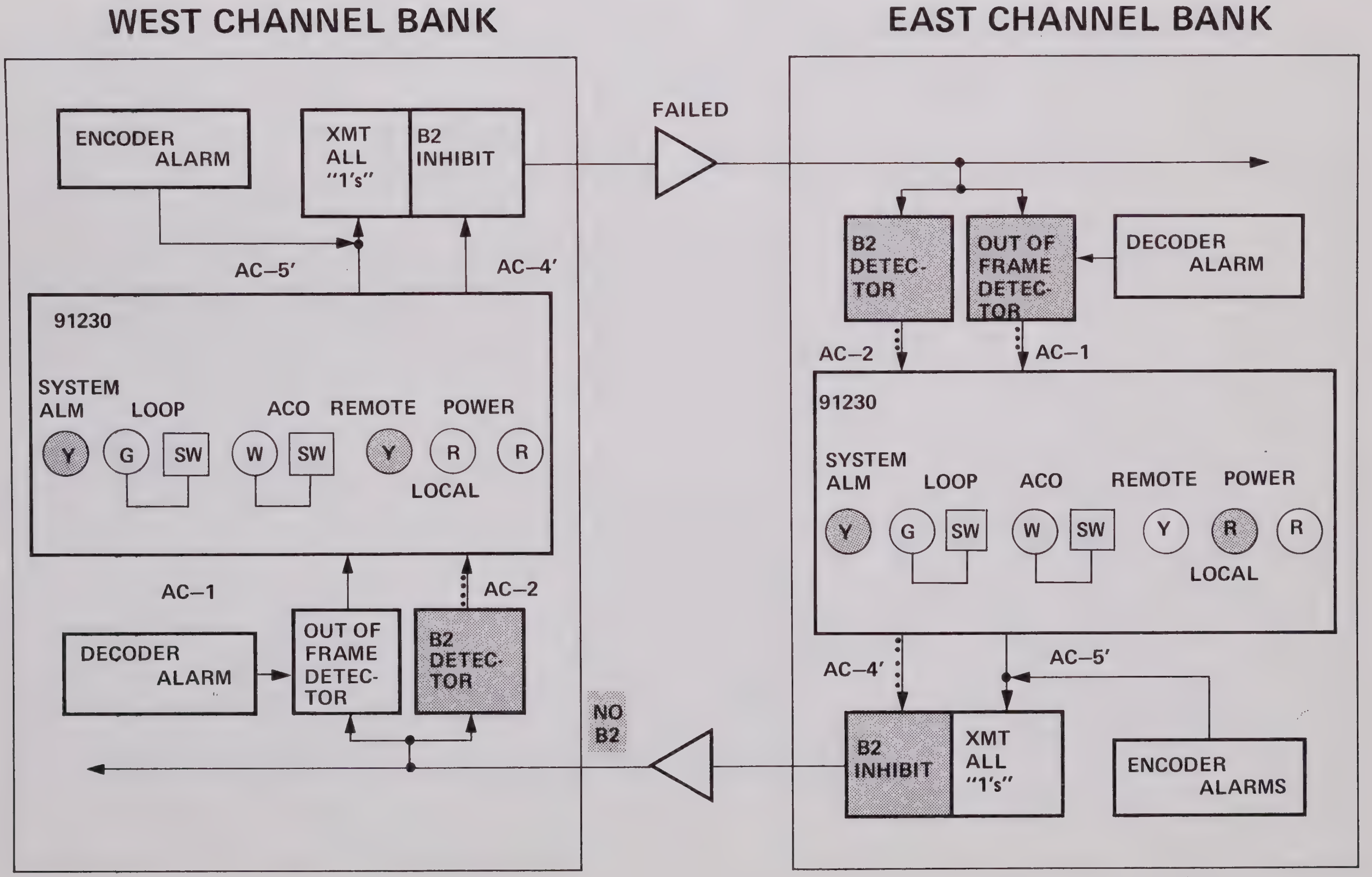
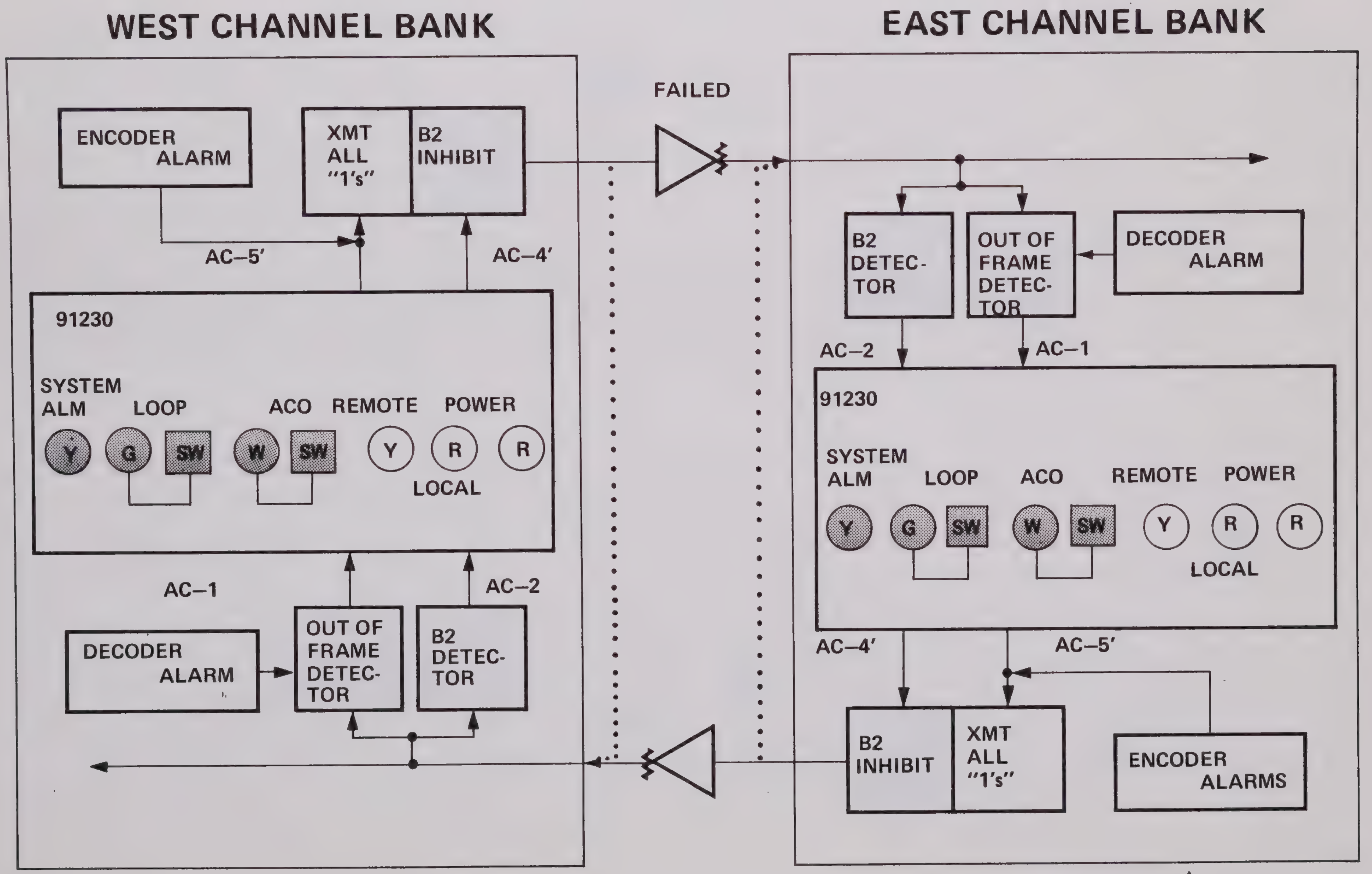
9002B SYSTEM ALARMS   REPEATER FAILURE—WEST TO EAST


WEST CHANNEL BANK
EAST CHANNEL BANK
ENCODER ALARM
XMT ALL "1's"
B2 INHIBIT
AC–5′
AC–4′
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–1
AC–2
DECODER ALARM
OUT OF FRAME DETEC-TOR
B2 DETEC-TOR
NO B2
FAILED
B2 DETEC-TOR
OUT OF FRAME DETEC-TOR
DECODER ALARM
AC–2
AC–1
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–4′
AC–5′
B2 INHIBIT
XMT ALL "1's"
ENCODER ALARMS

9002B SYSTEM ALARMS

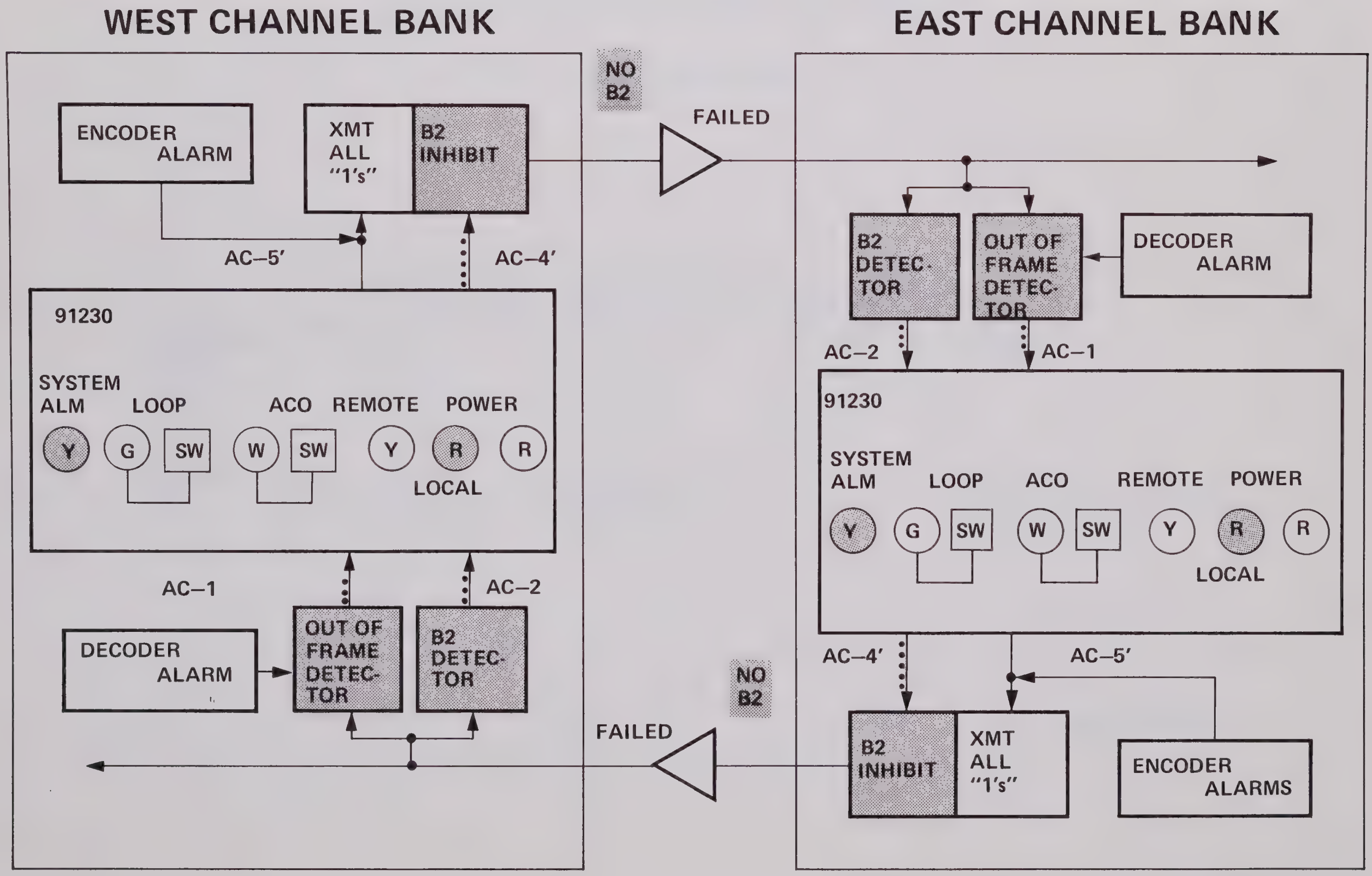
REPEATER FAILURE W—E— TERMS LOOPED


WEST CHANNEL BANK
EAST CHANNEL BANK
ENCODER ALARM
XMT ALL "1's"
B2 INHIBIT
AC–5′
AC–4′
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–1
AC–2
DECODER ALARM
OUT OF FRAME DETECTOR
B2 DETECTOR
FAILED
B2 DETECTOR
OUT OF FRAME DETECTOR
DECODER ALARM
AC–2
AC–1
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–4′
AC–5′
B2 INHIBIT
XMT ALL "1's"
ENCODER ALARMS

TR–911–316 △3

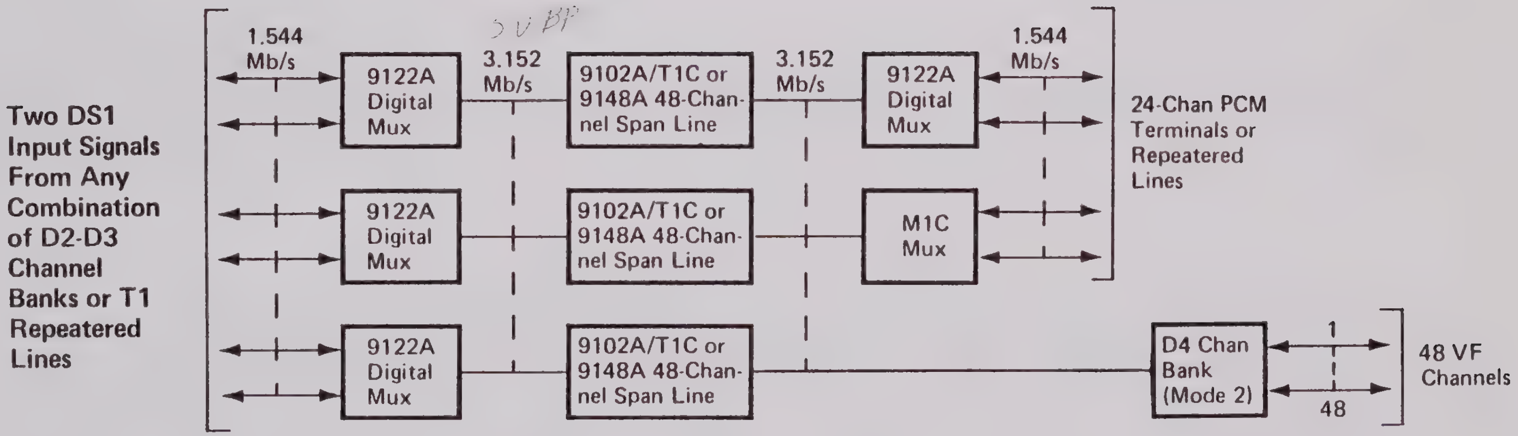
9002B SYSTEM ALARMS

REPEATER FAILURE— BOTH DIRECTIONS


WEST CHANNEL BANK
EAST CHANNEL BANK
ENCODER ALARM
XMT ALL "1's"
B2 INHIBIT
AC–5′
AC–4′
NO B2
FAILED
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–1
AC–2
DECODER ALARM
OUT OF FRAME DETECTOR
B2 DETECTOR
NO B2
FAILED
B2 DETECTOR
OUT OF FRAME DETECTOR
DECODER ALARM
AC–2
AC–1
91230
SYSTEM ALM
LOOP
ACO
REMOTE
POWER
Y
G
SW
W
SW
Y
R
R
LOCAL
AC–4′
AC–5′
B2 INHIBIT
XMT ALL "1's"
ENCODER ALARMS

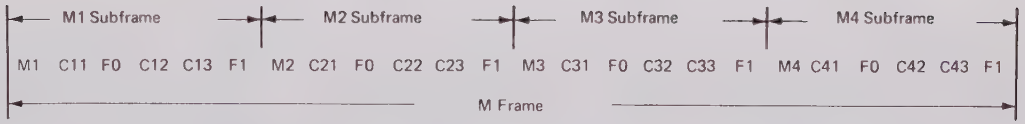
9122A DIGITAL MULTIPLEXER

APPLICATION

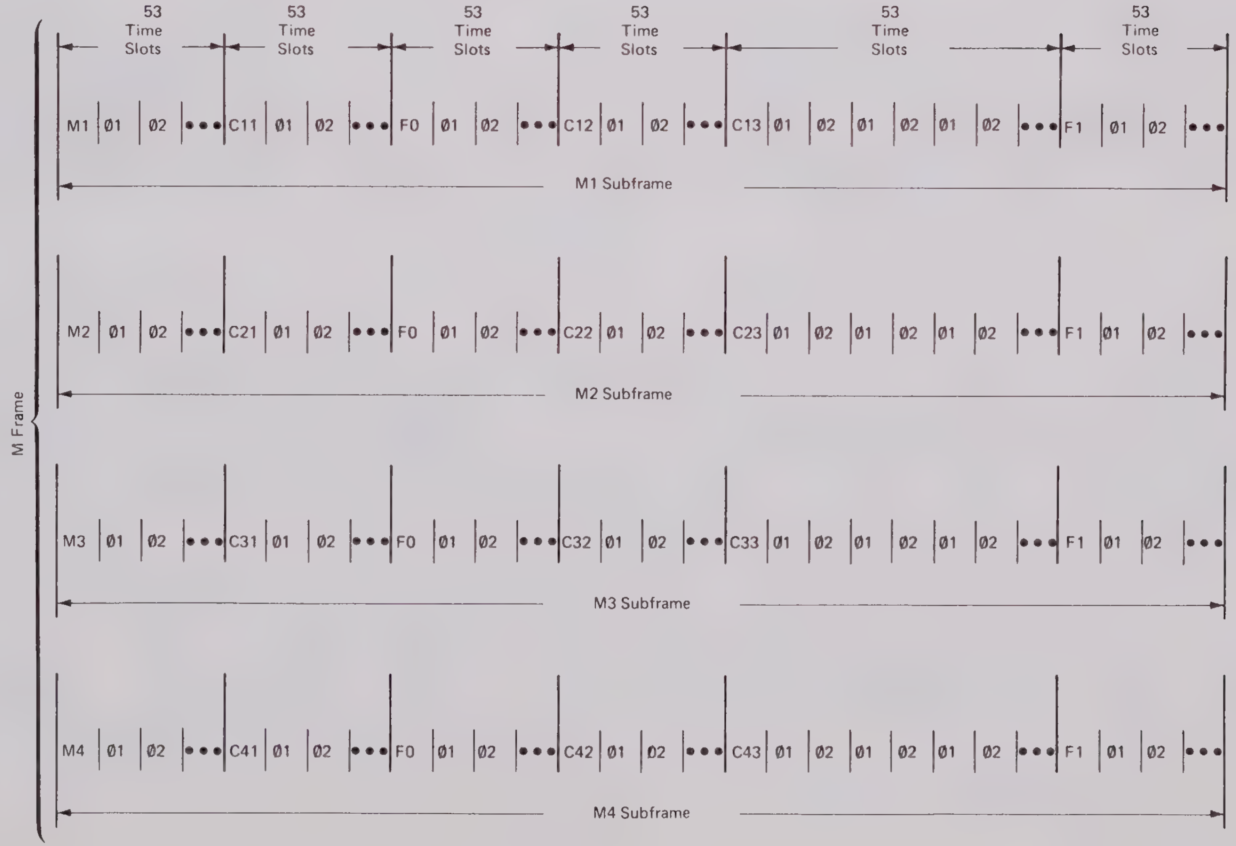

5 V BP
Two DS1 Input Signals From Any Combination of D2-D3 Channel Banks or T1 Repeatered Lines
1.544 Mb/s
9122A Digital Mux
9122A Digital Mux
9122A Digital Mux
3.152 Mb/s
9102A/T1C or 9148A 48-Channel Span Line
9102A/T1C or 9148A 48-Channel Span Line
9102A/T1C or 9148A 48-Channel Span Line
3.152 Mb/s
9122A Digital Mux
M1C Mux
1.544 Mb/s
24-Chan PCM Terminals or Repeatered Lines
D4 Chan Bank (Mode 2)
1
48
48 VF Channels

9122A TIMING

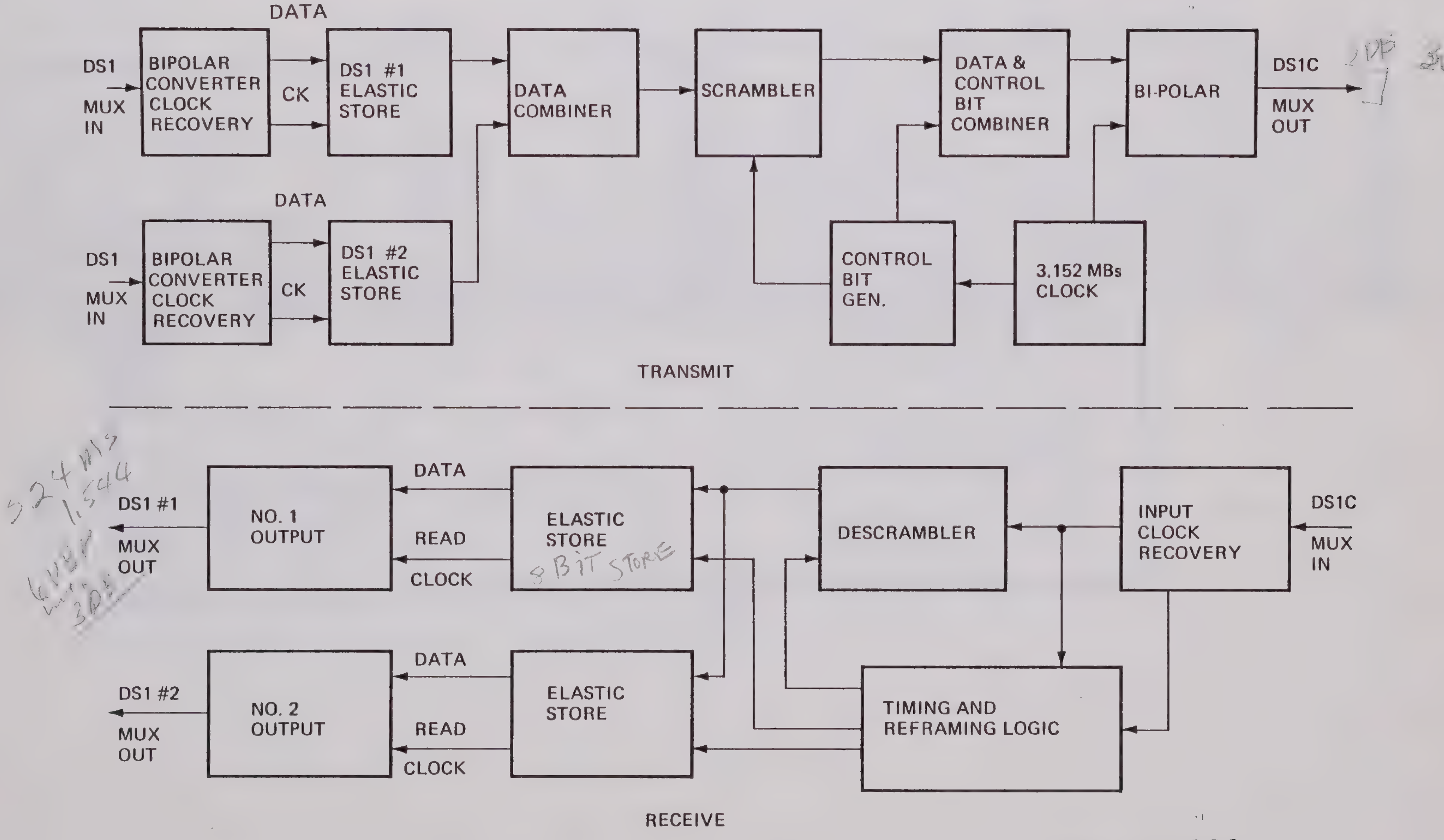
CONTROL BIT SEQUENCE.


M1 Subframe
M2 Subframe
M3 Subframe
M4 Subframe
M1 C11 F0 C12 C13 F1 M2 C21 F0 C22 C23 F1 M3 C31 F0 C32 C33 F1 M4 C41 F0 C42 C43 F1
M Frame

FORMAT OF DS1C DATA STREAM.

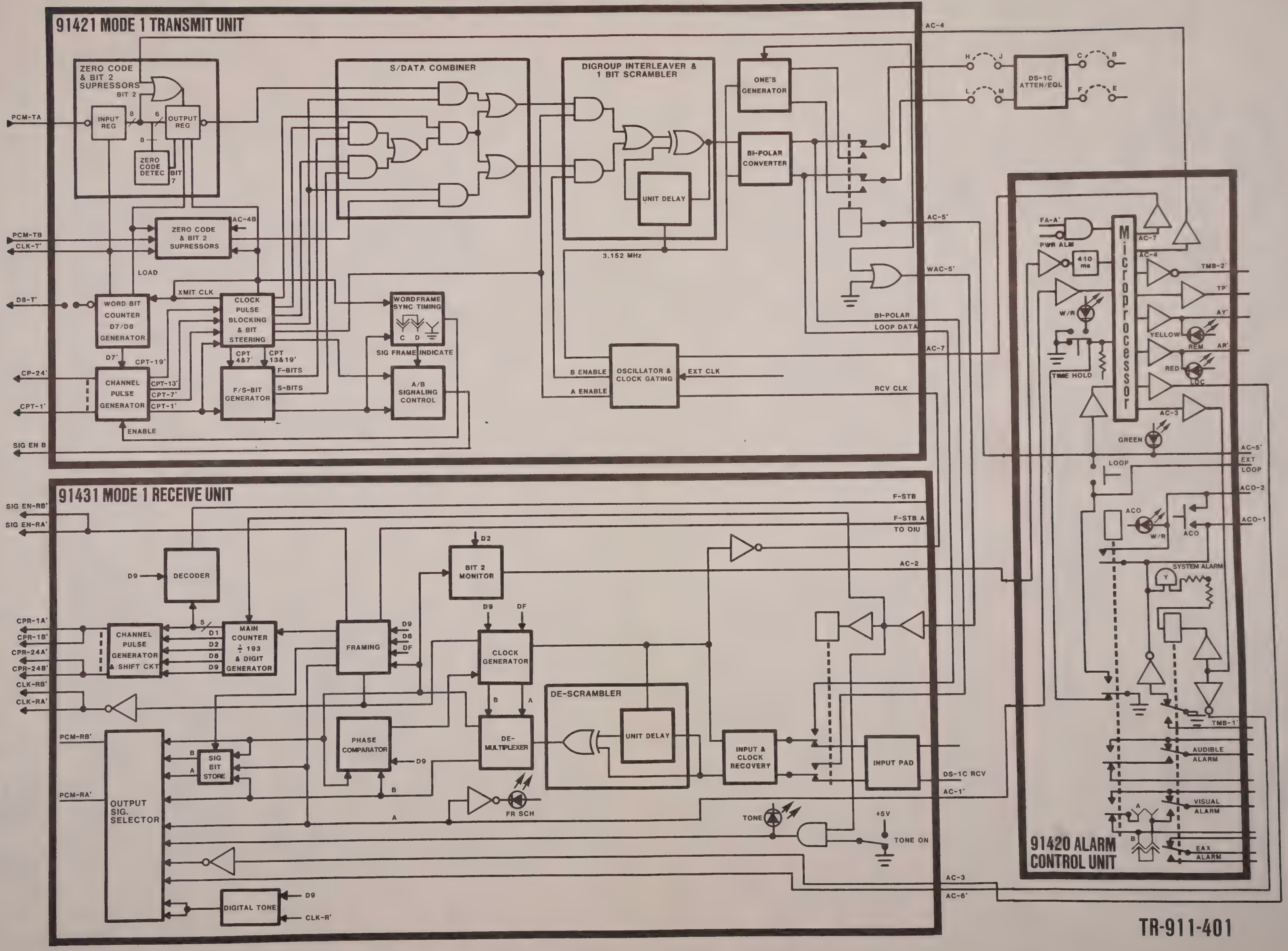

53 Time Slots
53 Time Slots
53 Time Slots
53 Time Slots
53 Time Slots
53 Time Slots
M1 01 02 ••• C11 01 02 ••• F0 01 02 ••• C12 01 02 ••• C13 01 02 01 02 01 02 ••• F1 01 02 •••
M1 Subframe
M2 01 02 ••• C21 01 02 ••• F0 01 02 ••• C22 01 02 ••• C23 01 02 01 02 01 02 ••• F1 01 02 •••
M2 Subframe
M3 01 02 ••• C31 01 02 ••• F0 01 02 ••• C32 01 02 ••• C33 01 02 01 02 01 02 ••• F1 01 02 •••
M3 Subframe
M4 01 02 ••• C41 01 02 ••• F0 01 02 ••• C42 01 02 ••• C43 01 02 01 02 01 02 ••• F1 01 02 •••
M4 Subframe
M Frame

9122A DIGITAL MULTIPLEXER BLOCK DIAGRAM

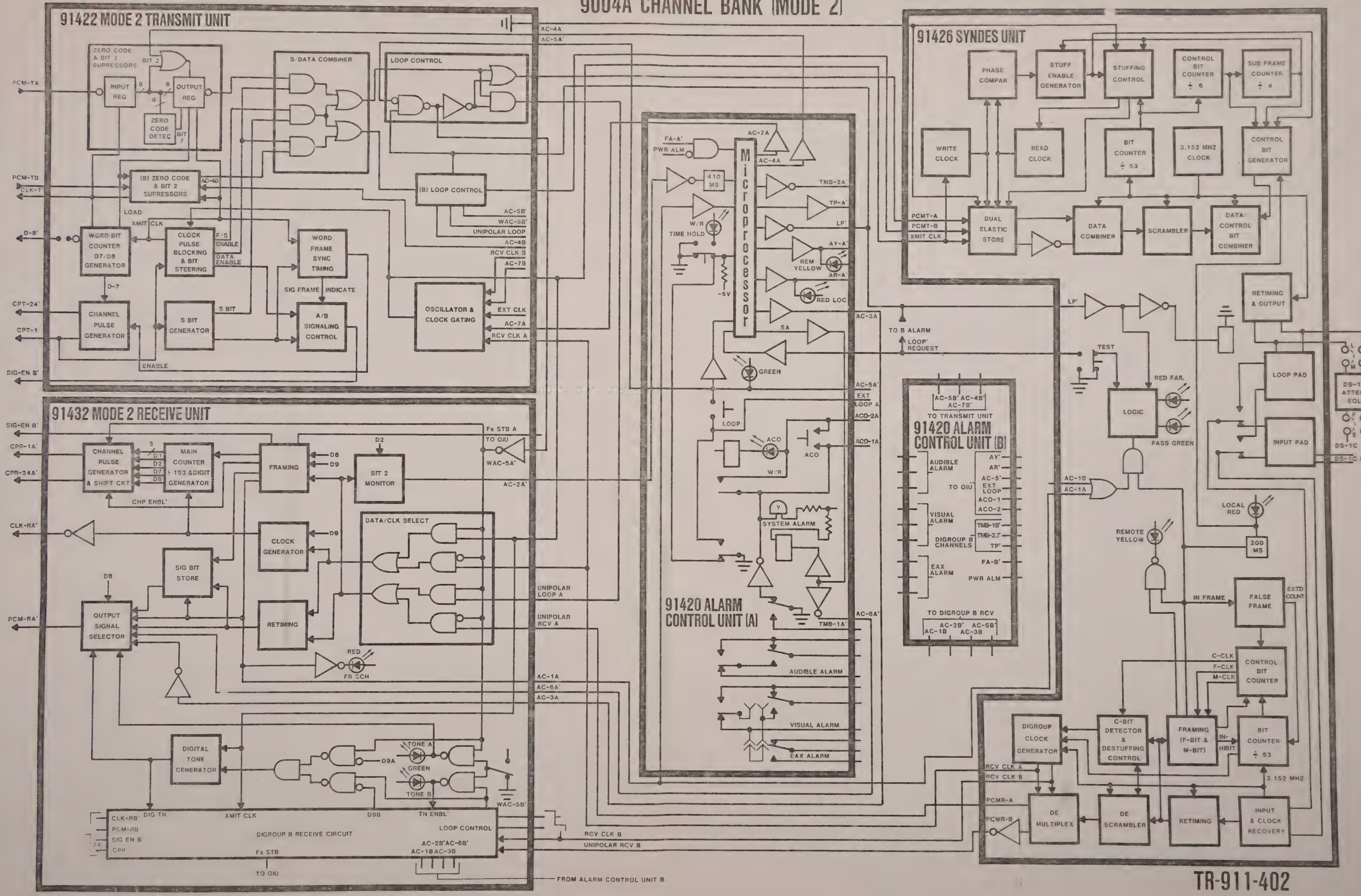

DATA
DS1
MUX IN
BIPOLAR CONVERTER CLOCK RECOVERY
CK
DS1 #1 ELASTIC STORE
DATA
DS1
MUX IN
BIPOLAR CONVERTER CLOCK RECOVERY
CK
DS1 #2 ELASTIC STORE
DATA COMBINER
SCRAMBLER
CONTROL BIT GEN.
DATA & CONTROL BIT COMBINER
3.152 MBs CLOCK
BI-POLAR
DS1C
MUX OUT
TRANSMIT
DS1C
MUX IN
INPUT CLOCK RECOVERY
DESCRAMBLER
TIMING AND REFRAMING LOGIC
ELASTIC STORE
8 BIT STORE
ELASTIC STORE
DATA
READ
CLOCK
DATA
READ
CLOCK
NO. 1 OUTPUT
NO. 2 OUTPUT
DS1 #1
MUX OUT
DS1 #2
MUX OUT
524
1.544
RECEIVE

TR-911-333

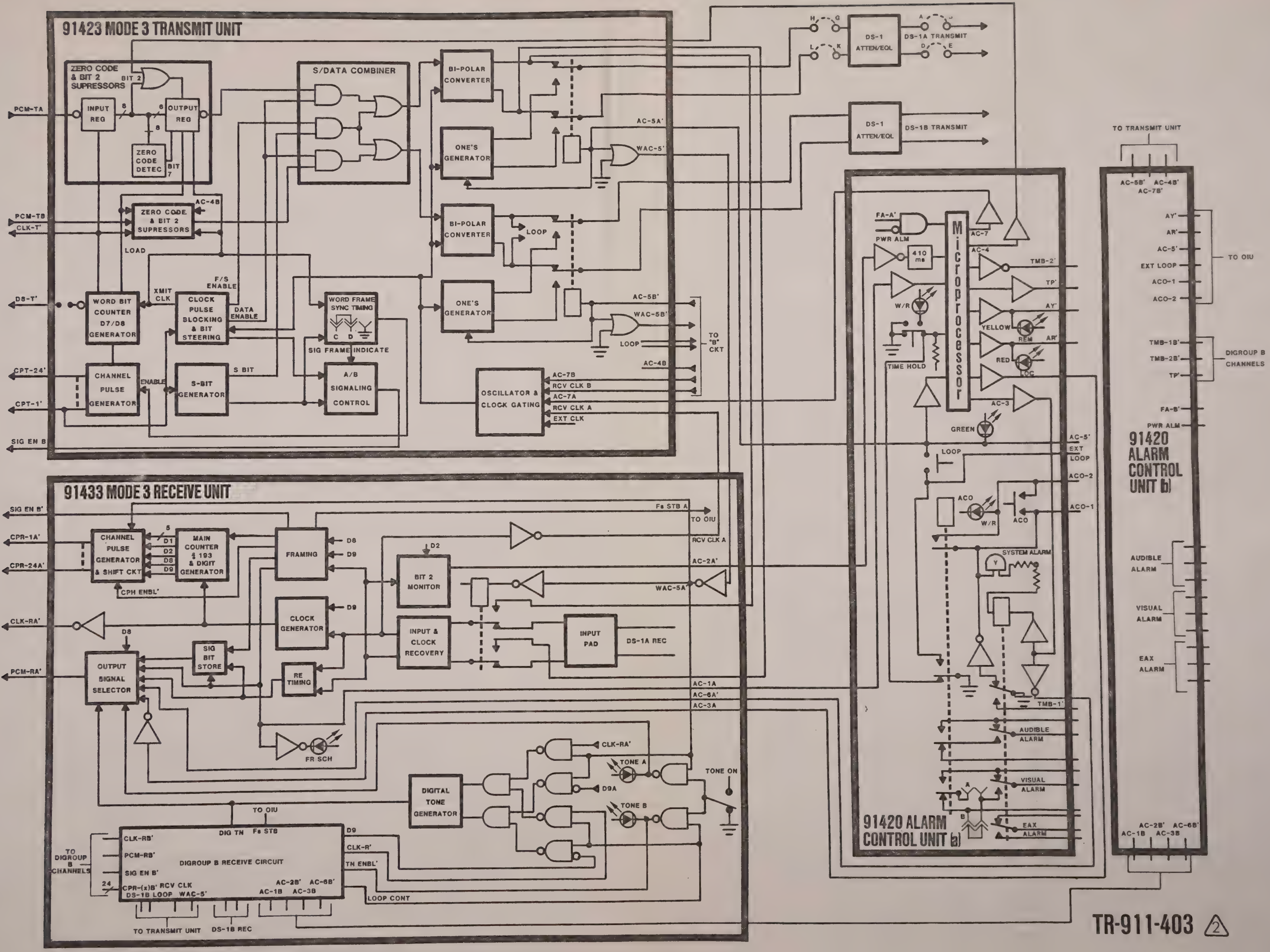
9004A CHANNEL BANK (MODE 1)


91421 MODE 1 TRANSMIT UNIT
ZERO CODE & BIT 2 SUPRESSORS
BIT 2
INPUT REG
OUTPUT REG
ZERO CODE DETEC
BIT 7
8
6
8
PCM-TA
PCM-TB
CLK-T'
ZERO CODE & BIT 2 SUPRESSORS
AC-4B
LOAD
D8-T'
WORD BIT COUNTER D7/D8 GENERATOR
XMIT CLK
CLOCK PULSE BLOCKING & BIT STEERING
D7'
CPT-19'
CP-24'
CHANNEL PULSE GENERATOR
CPT-13'
CPT-7'
CPT-1'
CPT-1'
ENABLE
SIG EN B
CPT 4&7'
CPT 13&19'
F-BITS
S-BITS
F/S-BIT GENERATOR
S/DATA COMBINER
WORDFRAME SYNC TIMING
C
D
SIG FRAME INDICATE
A/B SIGNALING CONTROL
DIGROUP INTERLEAVER & 1 BIT SCRAMBLER
UNIT DELAY
3.152 MHz
B ENABLE
A ENABLE
OSCILLATOR & CLOCK GATING
EXT CLK
ONE'S GENERATOR
BI-POLAR CONVERTER
AC-4
H
J
L
M
DS-1C ATTEN/EQL
C
B
F
E
AC-5'
WAC-5'
BI-POLAR
LOOP DATA
AC-7
RCV CLK
91431 MODE 1 RECEIVE UNIT
SIG EN-RB'
SIG EN-RA'
DECODER
D9
D2
BIT 2 MONITOR
F-STB
F-STB A TO OIU
AC-2
CPR-1A'
CPR-1B'
CPR-24A'
CPR-24B'
CLK-RB'
CLK-RA'
CHANNEL PULSE GENERATOR & SHIFT CKT
5
D1
D2
D8
D9
MAIN COUNTER ÷ 193 & DIGIT GENERATOR
FRAMING
D9
D8
DF
D9
DF
CLOCK GENERATOR
B
A
DE-SCRAMBLER
UNIT DELAY
DE-MULTIPLEXER
PHASE COMPARATOR
D9
B
PCM-RB'
PCM-RA'
OUTPUT SIG. SELECTOR
B
A
SIG BIT STORE
A
FR SCH
INPUT & CLOCK RECOVERY
INPUT PAD
DS-1C RCV
AC-1'
TONE
+5V
TONE ON
AC-3
AC-6'
DIGITAL TONE
D9
CLK-R'
91420 ALARM CONTROL UNIT
FA-A'
PWR ALM
410 ms
Microprocessor
AC-7
AC-4
W/R
TIME HOLD
TMB-2'
TP'
AY'
YELLOW
REM
AR'
RED
LOC
AC-3
GREEN
AC-5'
EXT
LOOP
LOOP
ACO-2
ACO
W/R
ACO
ACO-1
SYSTEM ALARM
Y
TMB-1'
AUDIBLE ALARM
VISUAL ALARM
A
B
EAX ALARM

9004A CHANNEL BANK (MODE 2)


91422 MODE 2 TRANSMIT UNIT
ZERO CODE & BIT 2 SUPRESSORS
BIT 2
INPUT REG
OUTPUT REG
ZERO CODE DETEC
BIT 7
PCM-TA
PCM-TB
CLK-T'
(B) ZERO CODE & BIT 2 SUPRESSORS
AC-4B
LOAD
XMIT CLK
D-8'
WORD BIT COUNTER D7/D8 GENERATOR
CLOCK PULSE BLOCKING & BIT STEERING
F/S ENABLE
DATA ENABLE
WORD FRAME SYNC TIMING
SIG FRAME
INDICATE
D-7
CPT-24'
CPT-1
CHANNEL PULSE GENERATOR
S BIT GENERATOR
S BIT
A/B SIGNALING CONTROL
ENABLE
SIG-EN B'
S/DATA COMBINER
LOOP CONTROL
(B) LOOP CONTROL
AC-5B'
WAC-5B'
UNIPOLAR LOOP
AC-4B
RCV CLK B
AC-7B
OSCILLATOR & CLOCK GATING
EXT CLK
AC-7A
RCV CLK A
AC-4A
AC-5A'
91432 MODE 2 RECEIVE UNIT
SIG-EN B'
CPR-1A'
CPR-24A'
CHANNEL PULSE GENERATOR & SHIFT CKT
MAIN COUNTER ÷ 193 &DIGIT GENERATOR
D1
D2
D7
D8
CHP ENBL'
FRAMING
D8
D9
D2
BIT 2 MONITOR
Fs STB A
TO OIU
WAC-5A'
AC-2A'
CLK-RA'
CLOCK GENERATOR
D9
DATA/CLK SELECT
SIG BIT STORE
D8
PCM-RA'
OUTPUT SIGNAL SELECTOR
RETIMING
UNIPOLAR LOOP A
UNIPOLAR RCV A
RED
FR SCH
AC-1A
AC-6A'
AC-3A
DIGITAL TONE GENERATOR
TONE A
D9A
GREEN
TONE B
WAC-5B'
CLK-RB'
PCM-RB
SIG EN B'
CPP
24
DIG TN
XMIT CLK
D9B
TN ENBL'
DIGROUP B RECEIVE CIRCUIT
LOOP CONTROL
AC-2B' AC-6B'
AC-1B AC-3B
Fs STB
TO OIU
FROM ALARM CONTROL UNIT B
RCV CLK B
UNIPOLAR RCV B
FA-A'
PWR ALM
AC-7A
AC-4A
Microprocessor
410 MS
TMB-2A'
TP-A'
LP'
AY-A'
AR-A'
W/R
TIME HOLD
-5V
REM YELLOW
RED LOC
SA
AC-3A
GREEN
AC-5A'
EXT LOOP A
ACO-2A
ACO-1A
LOOP
ACO
W/R
ACO
SYSTEM ALARM
Y
91420 ALARM CONTROL UNIT (A)
AC-6A'
TMB-1A'
AUDIBLE ALARM
VISUAL ALARM
EAX ALARM
TO B ALARM
LOOP' REQUEST
AC-5B' AC-4B' AC-7B'
TO TRANSMIT UNIT
91420 ALARM CONTROL UNIT (B)
AUDIBLE ALARM
TO OIU
VISUAL ALARM
DIGROUP B CHANNELS
EAX ALARM
AY'
AR'
AC-5'
EXT LOOP
ACO-1
ACO-2
TMB-1B'
TMB-2B'
TP'
FA-B'
PWR ALM
TO DIGROUP B RCV
AC-2B' AC-6B'
AC-1B AC-3B
91426 SYNDES UNIT
PHASE COMPAR
STUFF ENABLE GENERATOR
STUFFING CONTROL
CONTROL BIT COUNTER ÷ 6
SUB FRAME COUNTER ÷ 4
WRITE CLOCK
READ CLOCK
BIT COUNTER ÷ 53
3.152 MHZ CLOCK
CONTROL BIT GENERATOR
PCMT-A
PCMT-B
XMIT CLK
DUAL ELASTIC STORE
DATA COMBINER
SCRAMBLER
DATA CONTROL BIT COMBINER
LP'
RETIMING & OUTPUT
TEST
LOGIC
RED FAIL
PASS GREEN
LOOP PAD
INPUT PAD
L
H
M
J
DS-1C ATTEN EQL
F
C
E
B
DS-1C XMIT
DS-1C RCV
AC-1B
AC-1A
LOCAL RED
REMOTE YELLOW
200 MS
IN FRAME
FALSE FRAME
EXTD COUNT
C-CLK
F-CLK
M-CLK
CONTROL BIT COUNTER
DIGROUP CLOCK GENERATOR
C-BIT DETECTOR & DESTUFFING CONTROL
FRAMING (F-BIT & M-BIT)
IN-HIBIT
BIT COUNTER ÷ 53
3.152 MHZ
RCV CLK A
RCV CLK B
PCMR-A
PCMR-B
DE MULTIPLEX
DE SCRAMBLER
RETIMING
INPUT & CLOCK RECOVERY

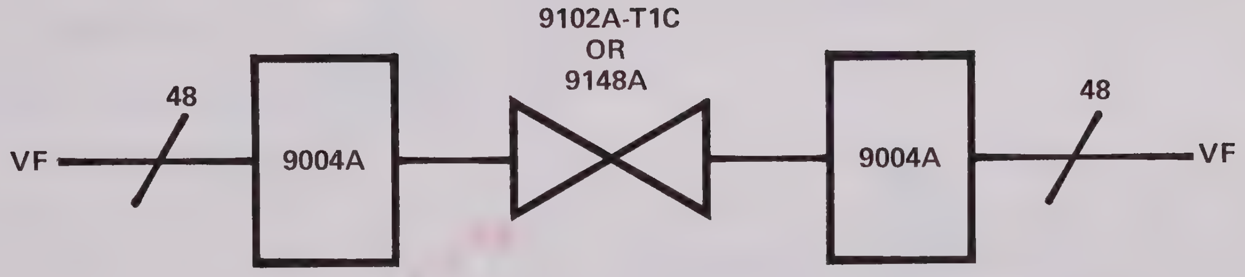
9004A CHANNEL BANK (MODE 3)


91423 MODE 3 TRANSMIT UNIT
ZERO CODE & BIT 2 SUPRESSORS
BIT 2
INPUT REG
OUTPUT REG
8
6
8
ZERO CODE DETEC
BIT 7
PCM-TA
S/DATA COMBINER
BI-POLAR CONVERTER
ONE'S GENERATOR
BI-POLAR CONVERTER
ONE'S GENERATOR
AC-5A'
WAC-5'
LOOP
PCM-TB
CLK-T'
ZERO CODE & BIT 2 SUPRESSORS
AC-4B
LOAD
F/S ENABLE
XMIT CLK
DATA ENABLE
D8-T'
WORD BIT COUNTER D7/D8 GENERATOR
CLOCK PULSE BLOCKING & BIT STEERING
WORD FRAME SYNC TIMING
C
D
SIG FRAME INDICATE
AC-5B'
WAC-5B'
LOOP
TO "B" CKT
AC-4B
CPT-24'
CPT-1'
CHANNEL PULSE GENERATOR
ENABLE
S-BIT GENERATOR
S BIT
A/B SIGNALING CONTROL
OSCILLATOR & CLOCK GATING
AC-7B
RCV CLK B
AC-7A
RCV CLK A
EXT CLK
SIG EN B
H
G
L
K
DS-1 ATTEN/EQL
A
J
D
E
DS-1A TRANSMIT
DS-1 ATTEN/EQL
DS-1B TRANSMIT
91433 MODE 3 RECEIVE UNIT
SIG EN B'
Fs STB A
TO OIU
CPR-1A'
CPR-24A'
CHANNEL PULSE GENERATOR & SHIFT CKT
5
D1
D2
D8
D9
MAIN COUNTER ÷ 193 & DIGIT GENERATOR
CPH ENBL'
FRAMING
D8
D9
RCV CLK A
D2
BIT 2 MONITOR
AC-2A'
WAC-5A'
CLK-RA'
CLOCK GENERATOR
D9
INPUT & CLOCK RECOVERY
INPUT PAD
DS-1A REC
D8
PCM-RA'
OUTPUT SIGNAL SELECTOR
SIG BIT STORE
RE TIMING
AC-1A
AC-6A'
AC-3A
FR SCH
CLK-RA'
TONE A
D9A
TONE B
TONE ON
DIGITAL TONE GENERATOR
TO OIU
DIG TN
Fs STB
D9
CLK-R'
TN ENBL'
LOOP CONT
TO DIGROUP B CHANNELS
CLK-RB'
PCM-RB'
SIG EN B'
24
CPR-(x)B'
RCV CLK
DIGROUP B RECEIVE CIRCUIT
DS-1B LOOP
WAC-5'
AC-2B'
AC-6B'
AC-1B
AC-3B
TO TRANSMIT UNIT
DS-1B REC
FA-A'
PWR ALM
410 ms
W/R
TIME HOLD
Microprocessor
AC-7
AC-4
TMB-2'
TP'
AY'
YELLOW
REM
AR'
RED
LOC
AC-3
GREEN
AC-5'
EXT LOOP
LOOP
ACO-2
ACO
W/R
ACO
ACO-1
SYSTEM ALARM
Y
TMB-1'
AUDIBLE ALARM
VISUAL ALARM
A
B
EAX ALARM
91420 ALARM CONTROL UNIT (a)
TO TRANSMIT UNIT
AC-5B'
AC-4B'
AC-7B'
AY'
AR'
AC-5'
EXT LOOP
ACO-1
ACO-2
TO OIU
TMB-1B'
TMB-2B'
TP'
DIGROUP B CHANNELS
FA-B'
PWR ALM
91420 ALARM CONTROL UNIT (b)
AUDIBLE ALARM
VISUAL ALARM
EAX ALARM
AC-2B'
AC-6B'
AC-1B
AC-3B

TR-911-403 ②

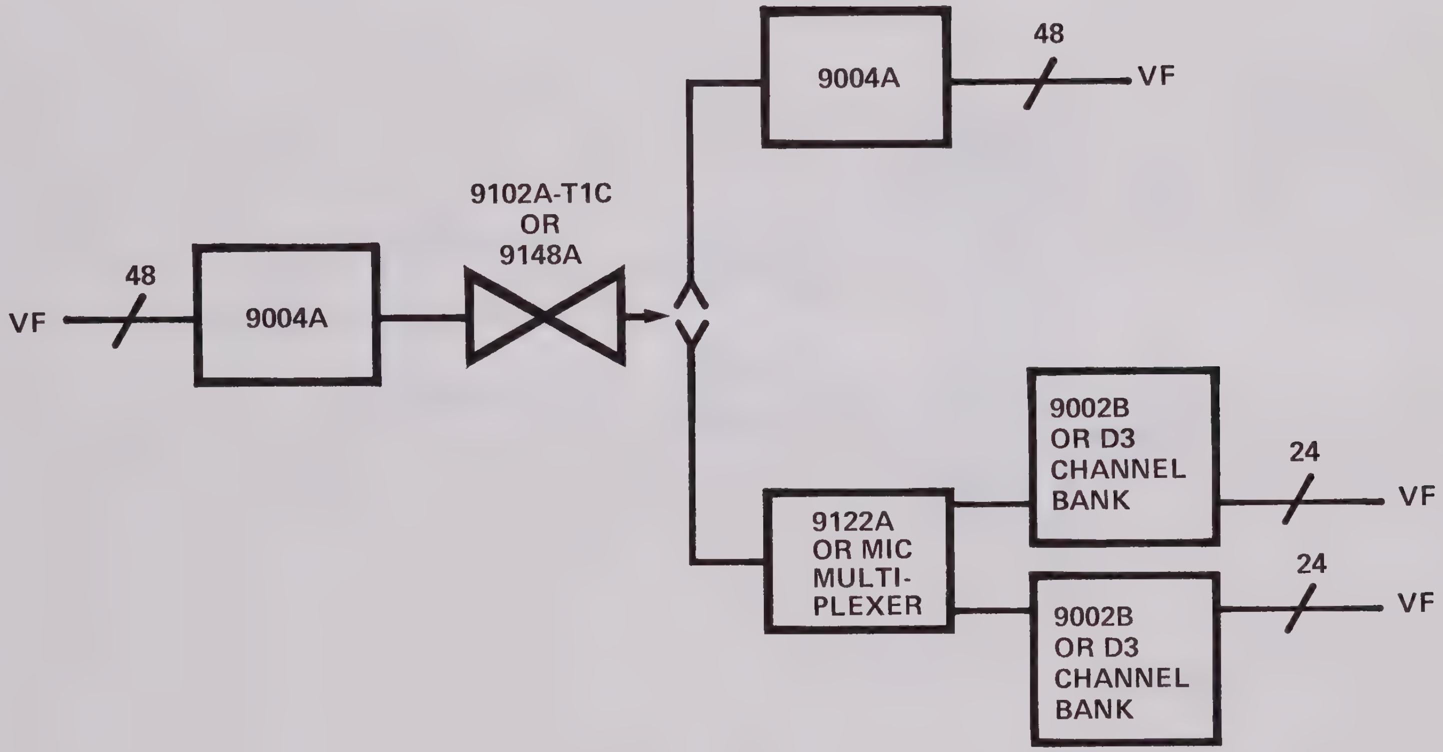
9004A CHANNEL BANK APPLICATION

MODE 1


9102A-T1C
OR
9148A
48
VF
9004A
9004A
48
VF

9004A CHANNEL BANK APPLICATION

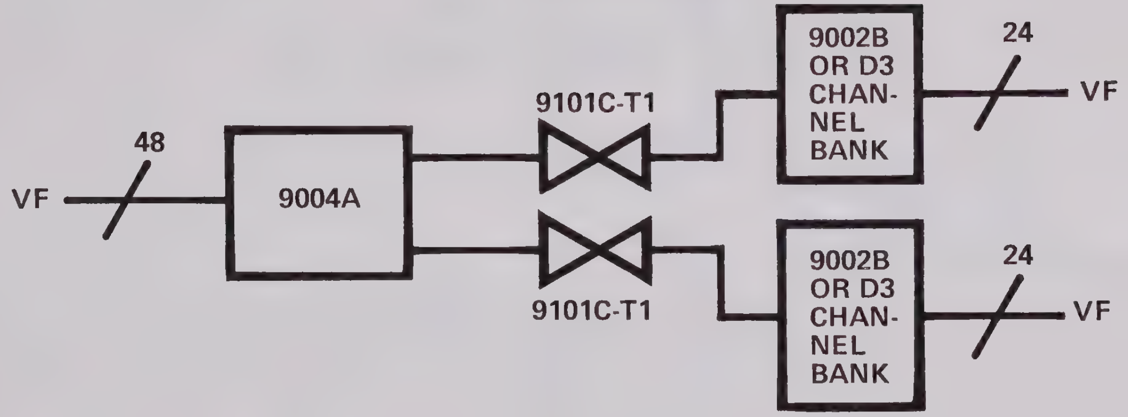
MODE 2


VF
48
9004A
9102A-T1C
OR
9148A
9004A
48
VF
9122A
OR MIC
MULTI-
PLEXER
9002B
OR D3
CHANNEL
BANK
24
VF
9002B
OR D3
CHANNEL
BANK
24
VF

TR-911-411

9004A CHANNEL BANK APPLICATION

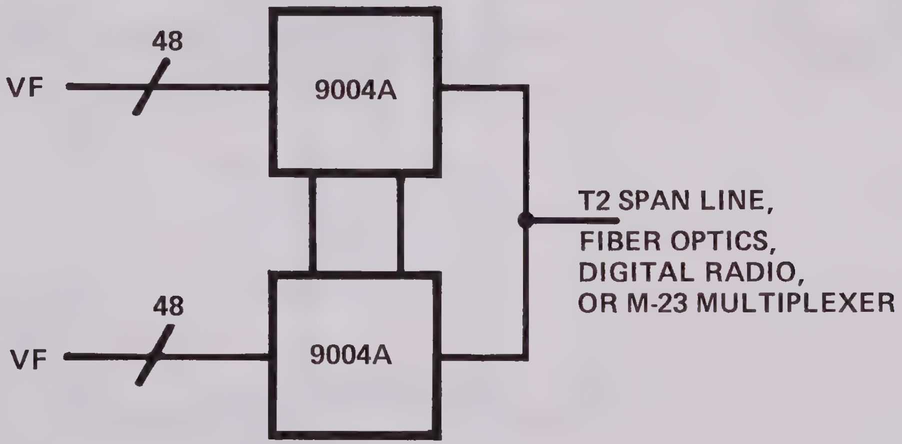
MODE 3


VF
48
9004A
9101C-T1
9101C-T1
9002B OR D3 CHAN-NEL BANK
9002B OR D3 CHAN-NEL BANK
24
VF
24
VF

TR-911-412

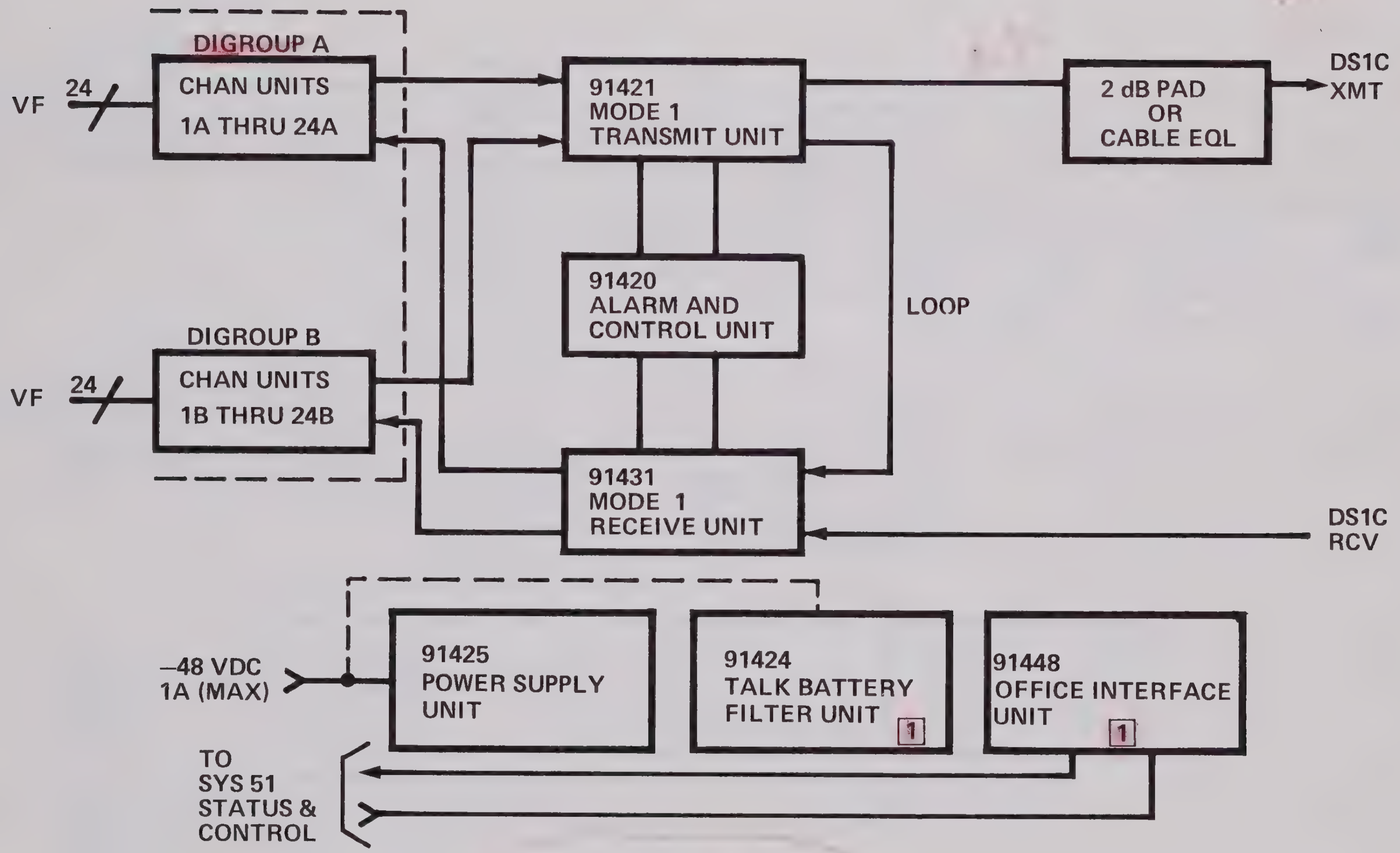
9004A CHANNEL BANK APPLICATION

MODE 4 (FUTURE)


48
VF
9004A
48
VF
9004A
T2 SPAN LINE,
FIBER OPTICS,
DIGITAL RADIO,
OR M-23 MULTIPLEXER

9004A COMMON EQUIPMENT

MODE 1

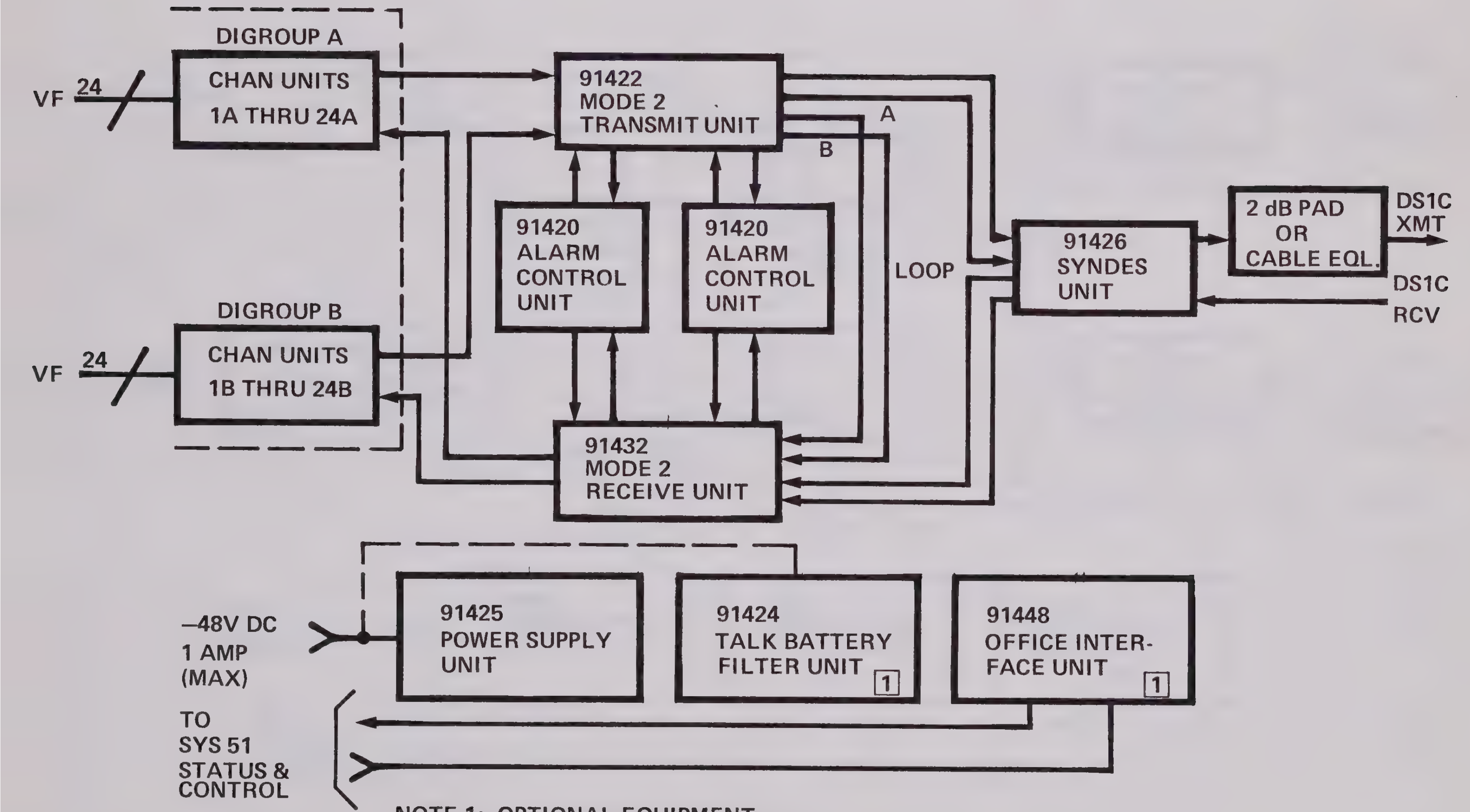

VF
24
DIGROUP A
CHAN UNITS
1A THRU 24A
VF
24
DIGROUP B
CHAN UNITS
1B THRU 24B
91421
MODE 1
TRANSMIT UNIT
91420
ALARM AND
CONTROL UNIT
91431
MODE 1
RECEIVE UNIT
LOOP
2 dB PAD
OR
CABLE EQL
DS1C
XMT
DS1C
RCV
–48 VDC
1A (MAX)
91425
POWER SUPPLY
UNIT
91424
TALK BATTERY
FILTER UNIT
1
91448
OFFICE INTERFACE
UNIT
1
TO
SYS 51
STATUS &
CONTROL

NOTE: 1. OPTIONAL EQUIPMENT.

TR-911-414

9004A COMMON EQUIPMENT

MODE 2

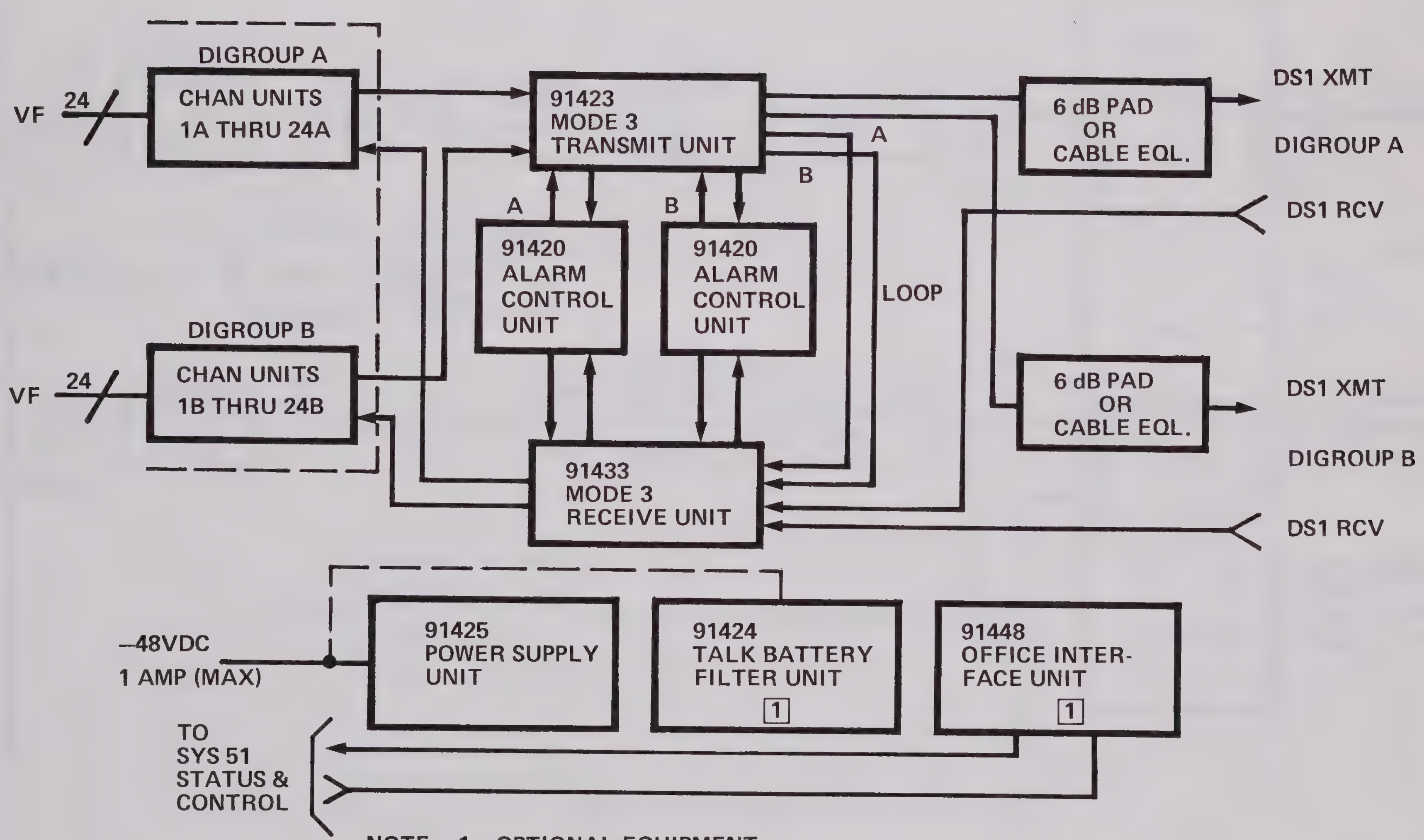

DIGROUP A
VF
24
CHAN UNITS
1A THRU 24A
DIGROUP B
VF
24
CHAN UNITS
1B THRU 24B
91422
MODE 2
TRANSMIT UNIT
A
B
91420
ALARM
CONTROL
UNIT
91420
ALARM
CONTROL
UNIT
LOOP
91432
MODE 2
RECEIVE UNIT
91426
SYNDES
UNIT
2 dB PAD
OR
CABLE EQL.
DS1C
XMT
DS1C
RCV
–48V DC
1 AMP
(MAX)
91425
POWER SUPPLY
UNIT
91424
TALK BATTERY
FILTER UNIT
1
91448
OFFICE INTER-
FACE UNIT
1
TO
SYS 51
STATUS &
CONTROL

NOTE 1: OPTIONAL EQUIPMENT.

TR-911-415

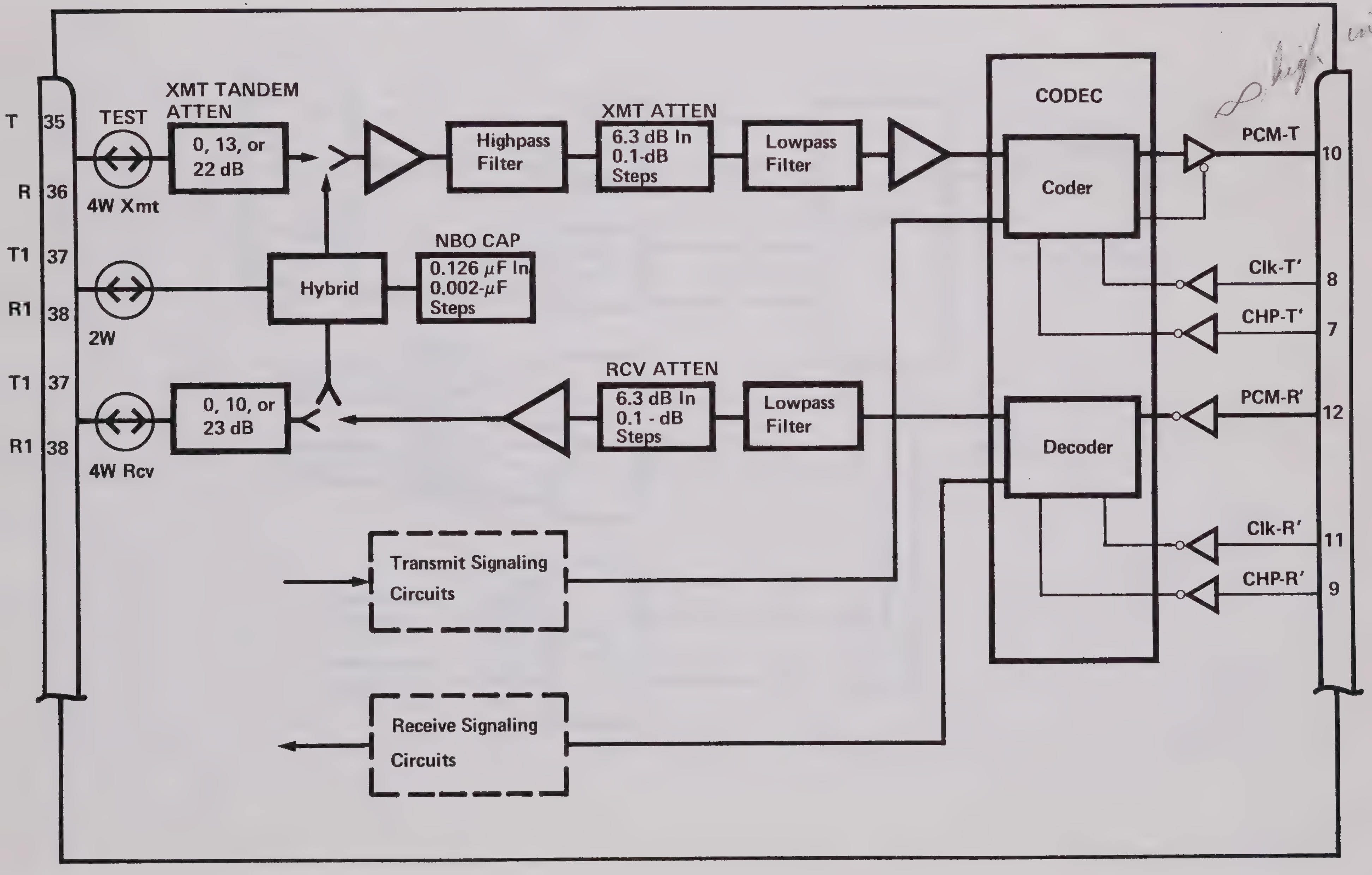
9004A COMMON EQUIPMENT

MODE 3

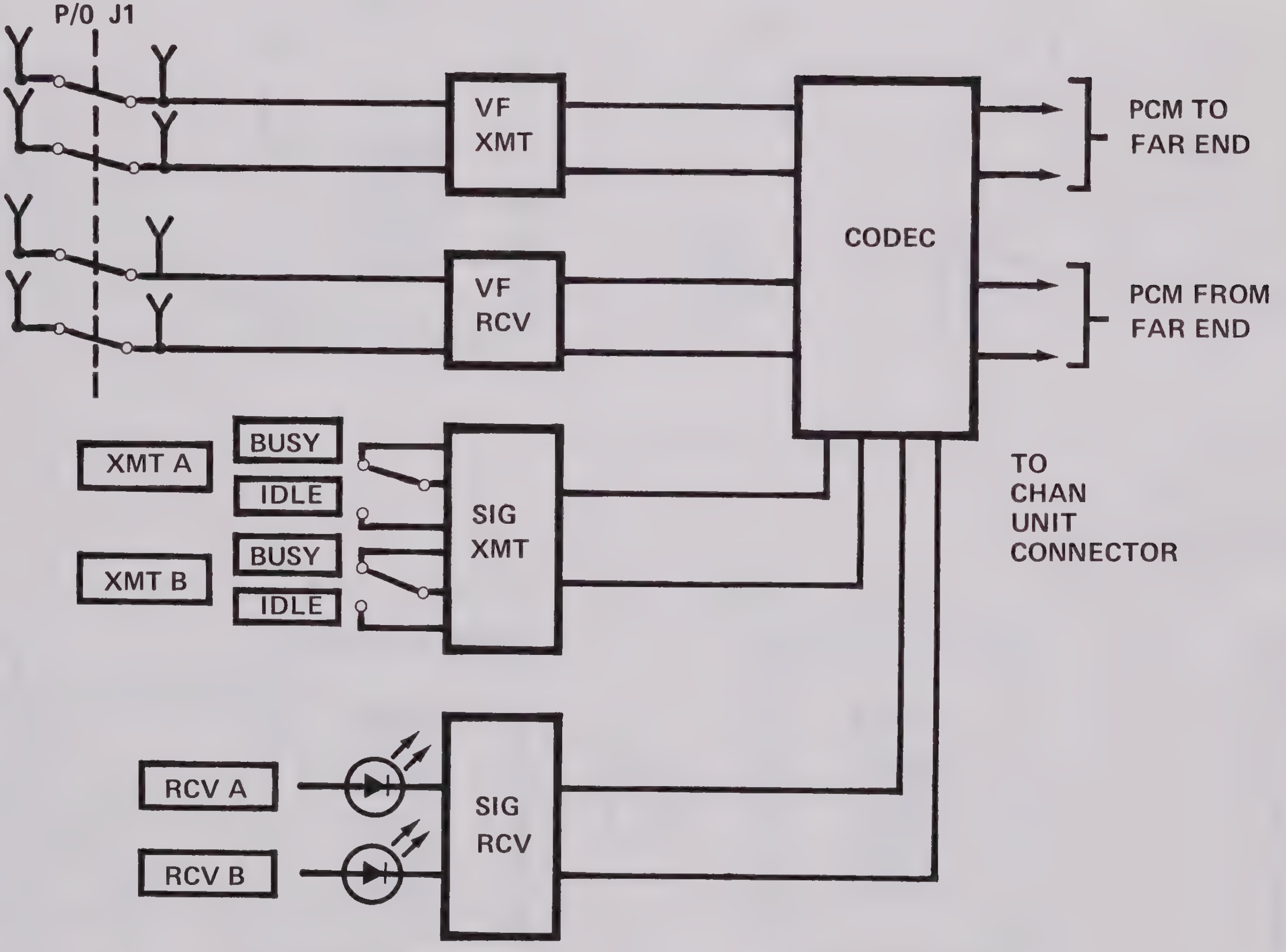

DIGROUP A
VF
24
CHAN UNITS
1A THRU 24A
DIGROUP B
VF
24
CHAN UNITS
1B THRU 24B
91423
MODE 3
TRANSMIT UNIT
A
B
91420
ALARM
CONTROL
UNIT
91420
ALARM
CONTROL
UNIT
A
B
LOOP
91433
MODE 3
RECEIVE UNIT
6 dB PAD
OR
CABLE EQL.
DS1 XMT
DIGROUP A
DS1 RCV
6 dB PAD
OR
CABLE EQL.
DS1 XMT
DIGROUP B
DS1 RCV
–48VDC
1 AMP (MAX)
91425
POWER SUPPLY
UNIT
91424
TALK BATTERY
FILTER UNIT
1
91448
OFFICE INTER-
FACE UNIT
1
TO
SYS 51
STATUS &
CONTROL

NOTE: 1. OPTIONAL EQUIPMENT.

CHANNEL UNIT BLOCK DIAGRAM


T
35
R
36
T1
37
R1
38
T1
37
R1
38
TEST
4W Xmt
2W
4W Rcv
XMT TANDEM ATTEN
0, 13, or 22 dB
Hybrid
NBO CAP
0.126 μF In 0.002-μF Steps
0, 10, or 23 dB
Highpass Filter
XMT ATTEN
6.3 dB In 0.1-dB Steps
Lowpass Filter
RCV ATTEN
6.3 dB In 0.1 - dB Steps
Lowpass Filter
Transmit Signaling Circuits
Receive Signaling Circuits
CODEC
Coder
Decoder
PCM-T
10
Clk-T′
8
CHP-T′
7
PCM-R′
12
Clk-R′
11
CHP-R′
9

91445 SIGNALING PATH TEST UNIT

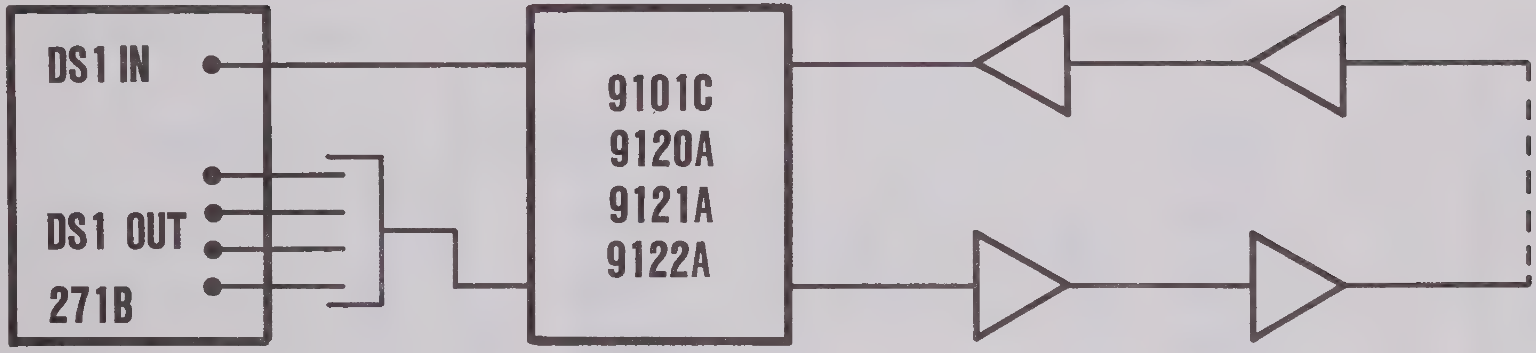

P/0 J1
VF XMT
VF RCV
CODEC
PCM TO FAR END
PCM FROM FAR END
TO CHAN UNIT CONNECTOR
XMT A
BUSY
IDLE
XMT B
BUSY
IDLE
SIG XMT
RCV A
RCV B
SIG RCV

TR-911-418

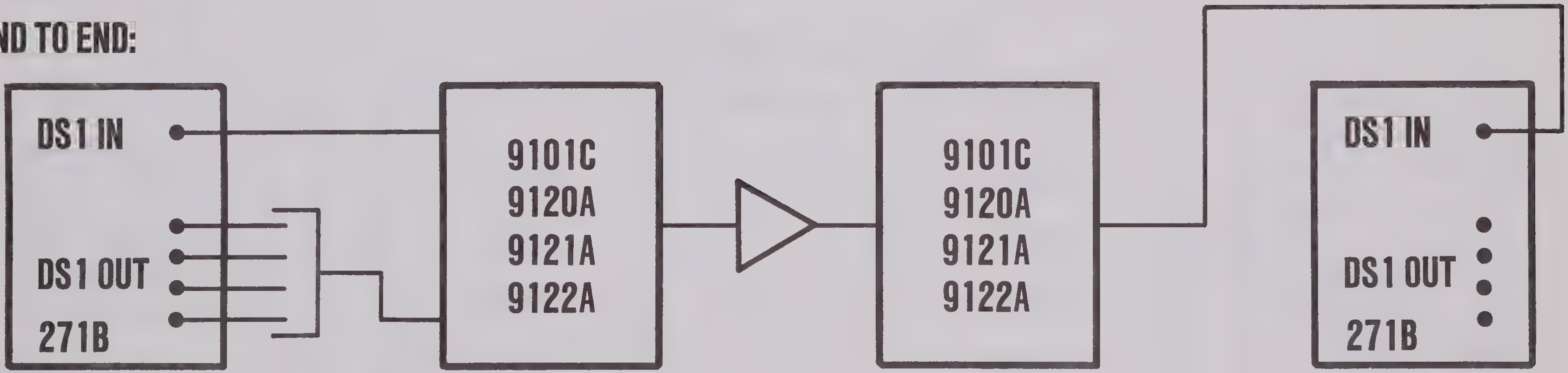
BOMAR 271B APPLICATIONS

TESTING DS1, DS1C, DS2

LOOPED:

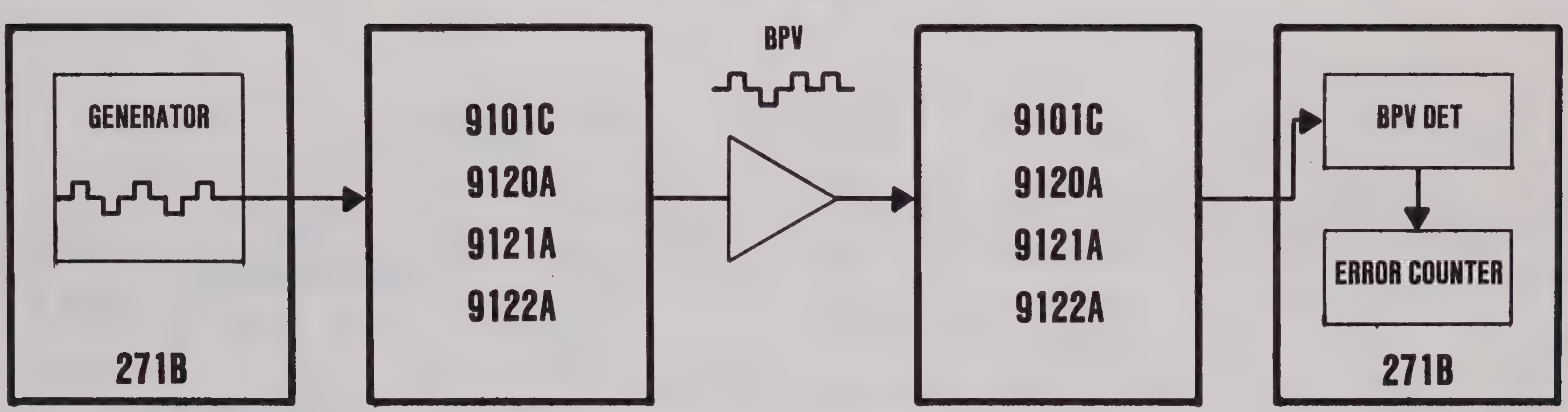

DS1 IN
DS1 OUT
271B
9101C
9120A
9121A
9122A

END TO END:

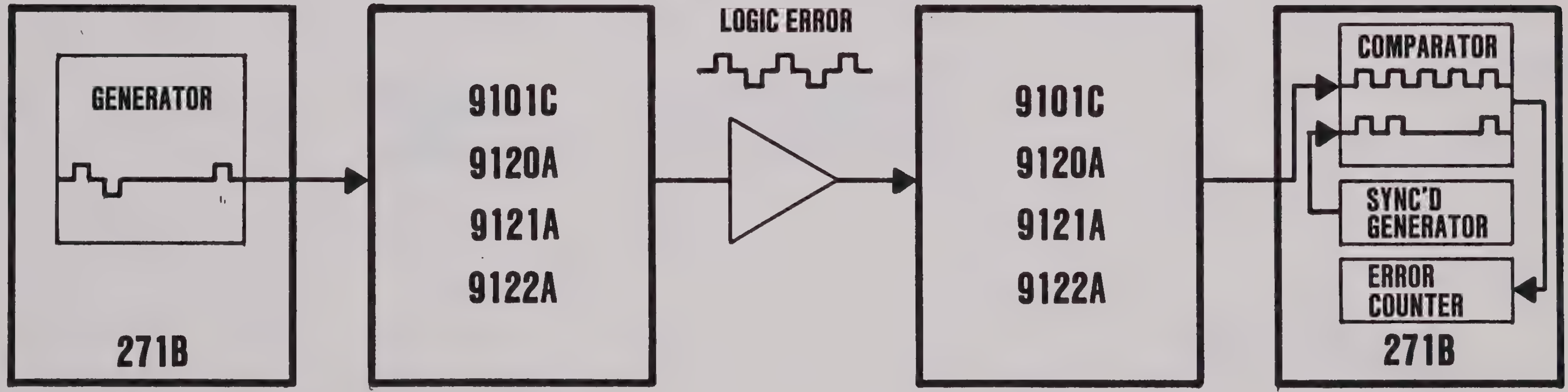

DS1 IN
DS1 OUT
271B
9101C
9120A
9121A
9122A
9101C
9120A
9121A
9122A
DS1 IN
DS1 OUT
271B

BOMAR 271B

BIPOLAR VIOLATION DETECTION

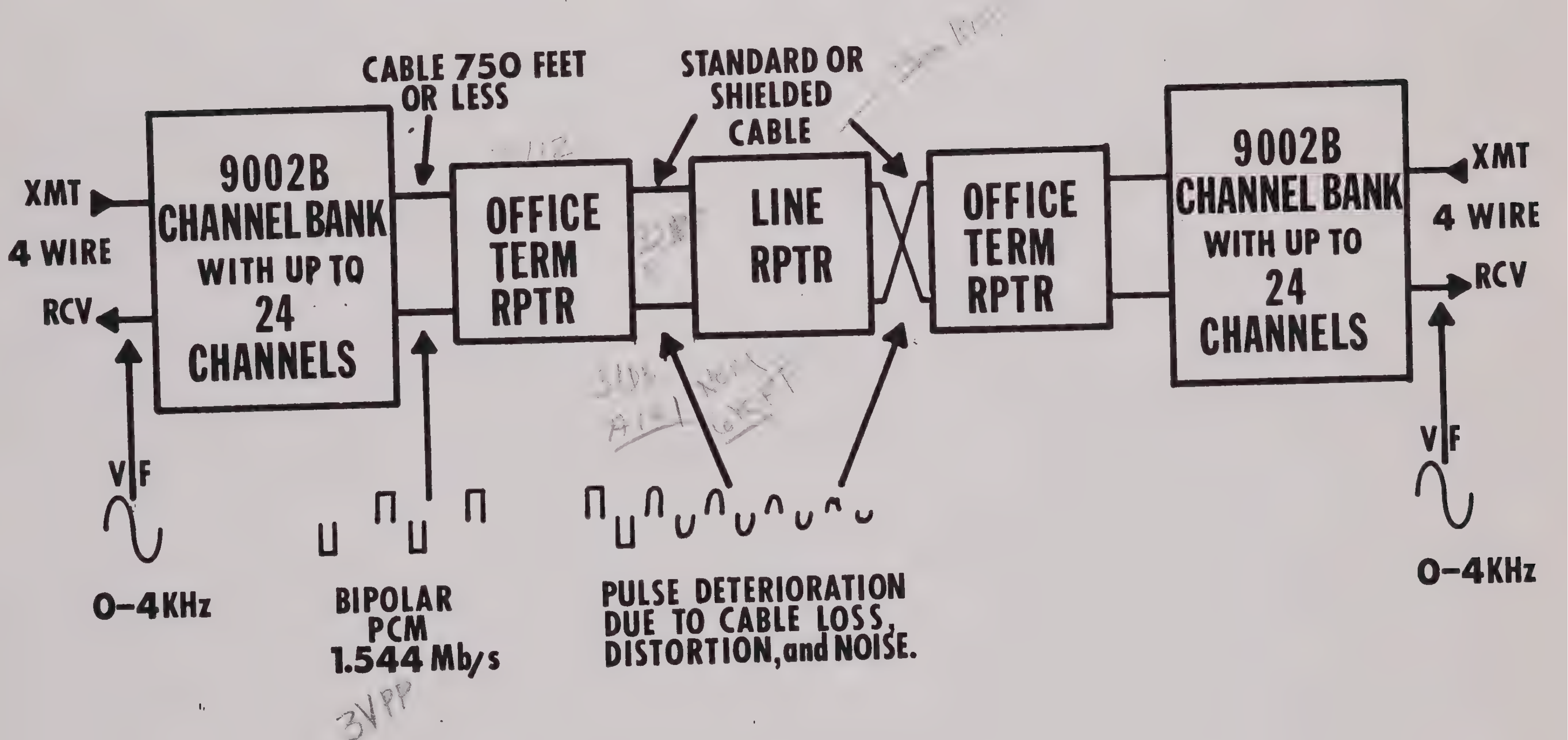

GENERATOR
271B
9101C
9120A
9121A
9122A
BPV
9101C
9120A
9121A
9122A
BPV DET
ERROR COUNTER
271B

LOGIC ERROR DETECTION


GENERATOR
271B
9101C
9120A
9121A
9122A
LOGIC ERROR
9101C
9120A
9121A
9122A
COMPARATOR
SYNC'D GENERATOR
ERROR COUNTER
271B

TR-911-081

91A PCM SYSTEM


CABLE 750 FEET OR LESS
STANDARD OR SHIELDED CABLE
XMT
4 WIRE
RCV
9002B CHANNEL BANK WITH UP TO 24 CHANNELS
OFFICE TERM RPTR
LINE RPTR
OFFICE TERM RPTR
9002B CHANNEL BANK WITH UP TO 24 CHANNELS
XMT
4 WIRE
RCV
VF
0–4KHz
BIPOLAR PCM 1.544 Mb/s
3VPP
PULSE DETERIORATION DUE TO CABLE LOSS, DISTORTION, and NOISE.
VF
0–4KHz

TR-911-200 ④

TR-911-150A
Issue 3
February, 1982

GTE LENKURT
INCORPORATED

91A PCM CABLE CARRIER COURSE
ANSWER SHEET #3

9122A Multiplexer

1. The DS1 inputs for System #1 would be wired to Jack ____J-1____,

   Pins ___30 & 32 - #2; 29 & 31 - #1___.

2. The Lenkurt part number for a cable equalizer when the DSX-1C is located 285 feet from the 9122A Multiplexer shelf is ___087-56705-04___.

3. What is the purpose of the MEM led indicator:

   To identify a muldem which has a transient or intermittent alarm that clears before a craftsperson can get to it.

4. The maximum current drawn by a fully equipped shelf is ___2.1___ Amps.

5. The 9122A may work end to end with what types of equipment?

   9122A, M1-C, D-4 (Mode 2)

6. When the 91481-01 muldem equipment shelf is equipped with 4 muldems, it must also have 2 91484 power supply units.

   T__________ F____X______

7. K-1 and K-2 on the 91485 Alarm panel are normally ___energized.___

8. The 9122A requires that the channel banks be co-located.

   T__________ F____X______

9. The DS1-C output is a 3.152 MB/S ___BI-POLAR___ signal and ___6___ volts peak to peak.

10. There is a ___3___ second delay from the time the fault causing the alarm is corrected before the mux alarm lamp goes out.

TR-911-150
Issue 3
February, 1982

GTE LENKURT
INCORPORATED

91A PCM CABLE CARRIER COURSE
PRACTICE EXERCISE #3

9122A Multiplexer

1. The DS1 inputs for System #1 would be wired to Jack J1, J3, J6, J8.

   Pins 29-31.

2. The Lenkurt part number for a cable equalizer when the DSX-1C is located 285 feet from the 9122A Multiplexer shelf is 087-5625-04.

   Page
   Fig 7-2

3. What is the purpose of the MEM led indicator:
   to identifie the muldem with alarm

   3.35

4. The maximum current drawn by a fully equipped shelf is 2.1 Amps.

5. The 9122A may work end to end with what types of equipment?
   DSX-1 and DSX-1C

6. When the 91481-01 muldem equipment shelf is equipped with 2 4 muldems, it must also have 1 2 91484 power supply units.

   T_____ F ✓ _____ 2.03

7. K-1 and K-2 on the 91485 Alarm panel are normally open -

8. The 9122A requires that the channel banks be co-located.

   T_____ F ✓

9. The DS1-C output is a 3.152 MB/S bipolar signal and 6 volts peak to peak.

10. There is a 3 second delay from the time the fault causing the alarm is corrected before the mux alarm lamp goes out. 3.32

TR-911-007A
Issue 5
February, 1982

GTE LENKURT
INCORPORATED

91A PCM CABLE CARRIER COURSE
ANSWER SHEET #1

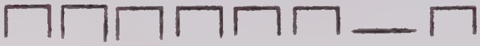
1. Convert the following binary numbers to base ten numbers.

   A. 1010101 ____85____
   B. 1001101 ____77____
   C. 1111111 ____127____

2. Convert the following base ten numbers to binary numbers.

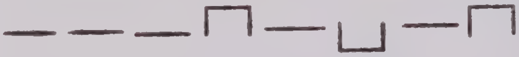
   A. 122 ____1111010____
   B. 70 ____1000110____
   C. 26 ____0011010____

3. Develop a 8 bit unipolar binary code for the quantum value of +125. (Note: show the 8 bit pulse stream as it would appear on a scope.)



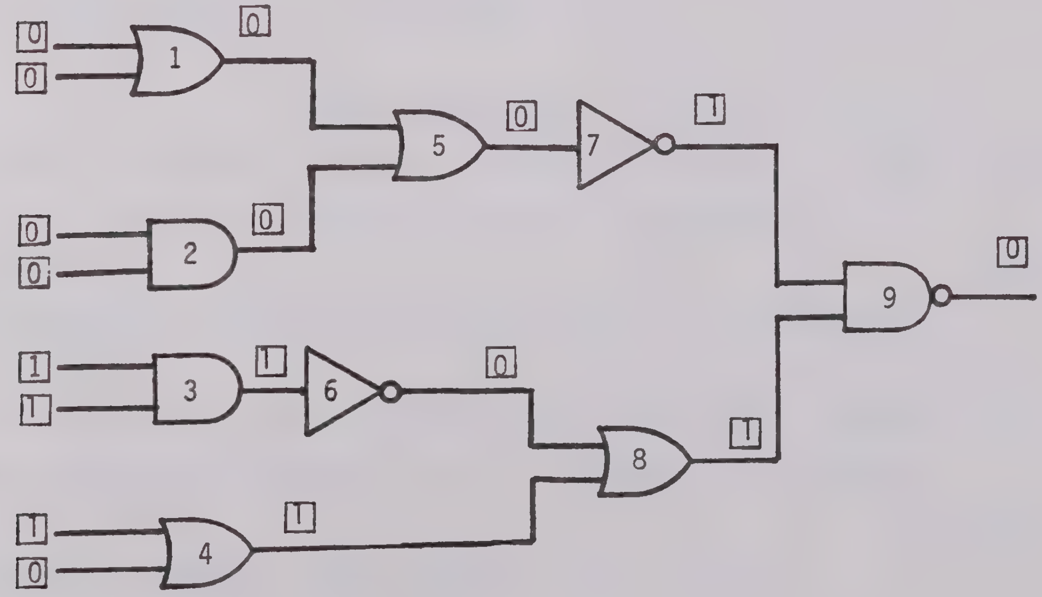
or 11111101

4. Develop a 8 bit bi-polar binary code for the quatum value of -21. (Note: show the 8 bit pulse stream as it would appear on a scope.)



or 00010101

5. In terms of logic 1's and logic 0's, fill in the squares in the following logic circuit.



6. The 9002B's transmitted pulse pattern is:

A. Unipolar   C. 24V P/P
[✓ B.] Bipolar   D. Sinusoidal

7. The channels are sampled in what order in the D-3 option?

1, 2, 3, 4

8. The 91232 test and alignment set analog oscillator operates at a frequency of 1025 hertz.

9. The decimal value of bit 4 in the 8 bit binary word is 16.

10. On the 91230 alarm and control unit, the $\overline{\text{PCM-T}}$ Input Pin 32 is a

Unipolar transmit PCM, neg. logic pulse 150± 10 nanoseconds duration.

11. The $\overline{\text{TMB}}$ Output Pin 31 is normally an open circuit.

12. The $\overline{\text{AC-4}}$ alarm lead Pin 38 is a logic 0 during a power alarm.

13. Show the factors which necessitate a linc rate of 1.544 Mb/s.

[(24) x (8) + (1)] x (8,000) = 1,544,000

14. The major source of noise in a PCM terminal is:

[✓ A.] Quantizing   C. Companding
B. Encoding   D. Sampling

15. The digital code produced in the 91232 test and alignment set is equivalent to 1,000 hertz, at 0 dBM0.

(CHECK THE MOST CORRECT ANSWER TO THE FOLLOWING STATEMENTS.)

16. A frame is made up of 193 time slots and is 125 u sec. in time. T X F

17. External S.F. in-band signaling equipment is required for 91A signaling. T F X

18. The 9002A and 9002B cannot be aligned using the same procedures and equipment. T F X

19. The receive clock is a crystal oscillator running at 1.544Mb/s. T F X

20. The pulse train delivered to the H.F. line facility is bipolar, 6V peak-to-peak. T X F

21. When both terminals in the system are 9002A, only bit 2 simultaneous restoral can be used. T F X

6. The 9002B's transmitted pulse pattern is:

   A. Unipolar [✓ B. Bipolar]
   C. 24V P/P
   D. Sinusoidal

7. The channels are sampled in what order in the D-3 option?

   1- 24 911-107- Fig 2-2

8. The 91232 test and alignment set analog oscillator operates at a frequency of 1025 hertz.

9. The decimal value of bit 4 in the 8 bit binary word is 16 bit.

10. On the 91230 alarm and control unit, the $\overline{\text{PCM-T}}$ Input Pin 32 is a (3.30)
    Loop back Generator! Converts the unbalanced unipolar transmit signal (PCM-T') to the signal input of the [illegible]

11. The $\overline{\text{TMB}}$ Output Pin 31 is normally an Open.

12. The $\overline{\text{AC-4}}$ alarm lead Pin 38 is a logic 0 during a power alarm. 911-107 3.75

13. Show the factors which necessitate a linc rate of 1.544 Mb/s.

    [(24) x (8) + (1)] x (8000) = 1,544,000

14. The major source of noise in a PCM terminal is:

    [✓ A. Quantizing]
    B. Encoding
    C. Companding
    D. Sampling

15. The digital code produced in the 91232 test and alignment set is equivalent to 1K hertz, at 0 dBM0. 3.95 342.911-107

(CHECK THE MOST CORRECT ANSWER TO THE FOLLOWING STATEMENTS.)

911-1 2.12

16. A frame is made up of 193 time slots and is 125 u sec. in time. T x F ____

17. External S.F. in-band signaling equipment is required for 91A signaling. T ____ F x

18. The 9002A and 9002B cannot be aligned using the same procedures and equipment. T ____ F X

19. The receive clock is a crystal oscillator running at 1.544Mb/s. T ____ F X

20. The pulse train delivered to the H.F. line facility is bipolar, 6V peak-to-peak. T X F ____

21. When both terminals in the system are 9002A, only bit 2 simultaneous restoral can be used. T ____ F x

911-110- 1.01

TR-911-007
Issue 5
February, 1982

GTE LENKURT
INCORPORATED

91A PCM CABLE CARRIER COURSE
PRACTICE EXERCISE #1

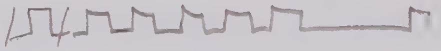
1. Convert the following binary numbers to base ten numbers.

   A. 1010101 85
   B. 1001101 77
   C. 1111111 127

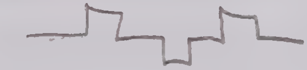
2. Convert the following base ten numbers to binary numbers.

   A. 122 0111010
   B. 70 100011
   C. 26 011010

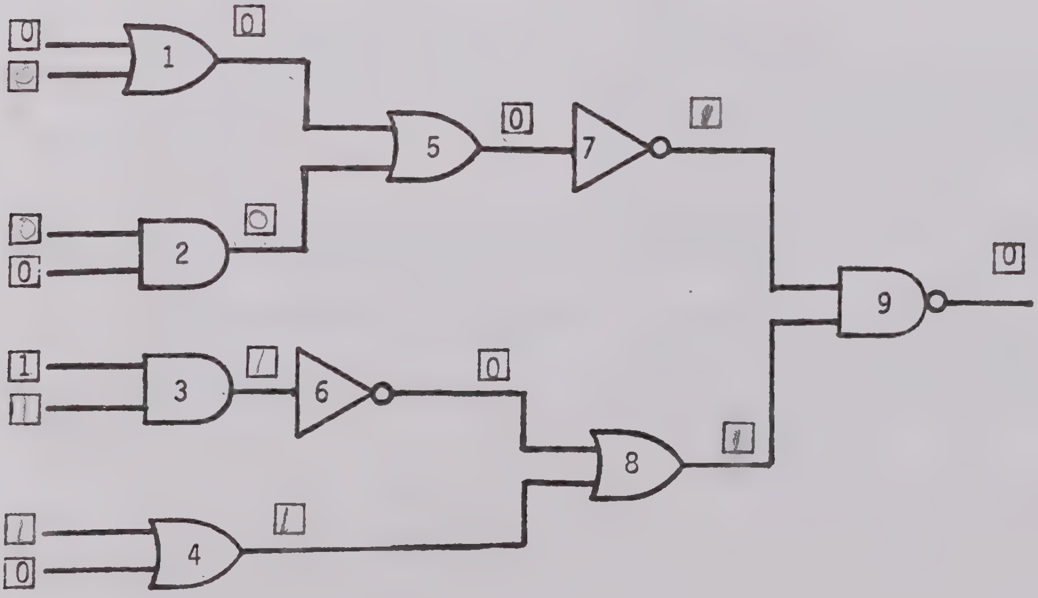
3. Develop a 8 bit unipolar binary code for the quantum value of +125. (Note: show the 8 bit pulse stream as it would appear on a scope.)



4. Develop a 8 bit bi-polar binary code for the quatum value of -21. (Note: show the 8 bit pulse stream as it would appear on a scope.)



5. In terms of logic 1's and logic 0's, fill in the squares in the following logic circuit.



GTE LENKURT
INCORPORATED

TR-911-407A
Issue 2
February, 1982

91A PCM CABLE CARRIER COURSE

ANSWER SHEET #2

1. Define the looped pulse pattern and bit rate for the three modes of 9004A.

Mode 1 Bipolar 3.152 Mb/s Mode 2 Unipolar 1.544 Mb/s Mode 3 Bipolar 1.544 Mb/s

2. What is the frequency of the clock in the 9004A operating Mode 1?

3.152 MHz

3. What does Syndes stand for?

Synchronizer-Desynchronizer

4. What does the 91420 Alarm Control Unit monitor in the Channel Bank?

1) Framing synchronization via the AC1 lead from the recieve unit.
2) System alarm status at the remote channel via the AC2' lead from the receive unit. 3) Output voltages of the 91425 Power Supply Unit via Pwr Alm lead. 4) Integrity of the PS, SIG, and TALK fuses on the 91400 shelf and the 20 Hz fuse on the 91424 Battery Filter Unit via the FA' lead.

5. When is the 91424 Battery Filter Unit required?

If the channel bank is to be equipped with one or more DPO or FXS channel units.

6. What is the strapping required for the 91400 Shelf and common equipment for Mode 2 operation with internal clock and signaling?

91400 Shelf strap B-C, E-F, H-J, L-M, Z

91422 Transmit Unit C, E, G.

7. How long of a service interruption occurs when the TEST push button on the Syndes unit is depressed?

300 ms

8. The 91420 Alarm Control Unit supplies two TMB signals and a timing signal (TP') to the channel units. What generates these signals?

TMB1' by the SA relay

TMB2' and TP' by the microcomputer

9. What option differences are there between a 91443-01 and -02?

-01: Two sets of channel unit access jacks, plus option code if applicable

-02: Four sets of channel unit access jacks, option codes are not applicable

10. Define ERL and SRL.

Echo Return Loss (ERL) is the average weighted loss in the 500-2500 Hz band.

Singing Return Loss (SRL) is the average weighted loss in the singing bands 200-500 Hz and 2500-3200 Hz.

11. What are the advantages of Single Codec operation verses Common Codec operations?

1) Crosstalk is virtually eliminated

2) Field adjustment of VF levels is not required.

12. In the 9004A: how long after an out-of-frame condition is detected does a system alarm take place?

2.5 seconds

(Indicate by circling the most correct answer or answers to the following:)

13. If the transmit unit fails or is removed from the shelf, the following occurs:

    [✓ a.] local REMOTE lamp and distant LOCAL lamp will light

    b. local LOCAL lamp and distant REMOTE lamp will light

    [✓ c.] SYSTEM ALARM lamps will light at both end terminals

    d. none of the above

14. The steps required to convert analog to digital are:

    [✓ a.] sampling

    b. slicing

    c. linearizing

    [✓ d.] quantizing

    [✓ e.] encoding

    f. multiplexing

15. A terminal LOCAL alarm lamp can be caused by which of the following?

    [✓ a.] The distant transmitter not transmitting a proper framing pulse

    b. The local transmitter not transmitting a proper framing pulse

    c. A defective distant receiver

    [✓ d.] A defective local receiver

    e. A defective outgoing repeatered line

    [✓ f.] A defective incoming repeatered line

16. The system will alarm on which of the following?

    [✓ a.] Loss of power

    b. Loss of a VF channel

    [✓ c.] Prolonged absence of B2

    d. Loss of a 12-channel group

    [✓ e.] Absence of framing pulse

17. Noise specification of 13dBRNC0 is measured in a properly aligned standard level 4 wire system as ____100____ PWC.

18. If the standard VTVM meter indicates a reading of -21dB at 75 ohm test point, what is the dBM value?

A. -21 dBM   C. -30 dBM
B. -18 dBM   [✓ D.] -12 dBM

19. Which unit would you replace first for the following alarm lamp indications?

Before looping - System alarm lamp lit
Remote alarm lamp lit

After looping - System alarm lamp lit
ACO lamp lit
Loop lamp lit
Remote alarm lamp lit
Local alarm lamp lit

____TRANSMIT____

20. Which unit would you replace next if the first one did not correct the problem?

____ALARM CARD____

21. Which unit would you replace first for the following alarm lamp indications?

Before looping - System alarm lamp lit
Local alarm lamp lit

After looping - System alarm lamp lit
ACO lamp lit
Loop lamp lit
Local alarm lamp lit

____RECEIVE UNIT____

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91A PCM CABLE CARRIER COURSE

PRACTICE EXERCISE #2

1. Define the looped pulse pattern and bit rate for the three modes of 9004A.

Bipolar UnPo Bip 3.08

Mode 1 3.152 Mb/s Mode 2 1.544 Mb/s Mode 3 1.544 Mb/s

2. What is the frequency of the clock in the 9004A operating Mode 1?

1.576 (3.15)

3. What does Syndes stand for?

Synchronizing and [illegible] transmit signal of category A — B — see add - page 7

4. What does the 91420 Alarm Control Unit monitor in the Channel Bank?

Monitor channel bank status and provides [illegible] indications + system alarm, delay initiate for office alarm (O2) is equipped with, [illegible] the [illegible] system alarm [illegible] signal

5. When is the 91424 Battery Filter Unit required?

4.0: only if the channel bank will be equipped with over 5 [illegible] DPO of FXS.

6. What is the strapping required for the 91400 Shelf and common equipment for Mode 2 operation with internal clock and signaling?

internal clock E G, looped received clock F G

External clock E H

7. How long of a service interruption occurs when the TEST push button on the Syndes unit is depressed?

300 ms (3.140)

8. The 91420 Alarm Control Unit supplies two TMB signals and a timing signal (TP') to the channel units. What generates these signals?

TMB1 is the SA relay from the Microcomputer

the TP' & TMB2 is by the Microcomputer

9. What option differences are there between a 91443-01 and -02?

Four out of channel unit access pads options

[illegible] are not applicable.

10. Define ERL and SRL.

echo level loss - 28 DB - min 5.30 - PAR (d)

Singing level loss 20 DB min

11. What are the advantages of Single Codec operation verses Common Codec operations?

Crosstalk is virtually eliminated, field

adjustment of VF level is not required

12. In the 9004A: how long after an out-of-frame condition is detected does a system alarm take place?

2.5 sec (2.33)

(Indicate by circling the most correct answer or answers to the following:)

13. If the transmit unit fails or is removed from the shelf, the following occurs:

    [✓ a. local REMOTE lamp and distant LOCAL lamp will light]

    b. local LOCAL lamp and distant REMOTE lamp will light

    c. SYSTEM ALARM lamps will light at both end terminals

    d. none of the above

14. The steps required to convert analog to digital are:

    [✓ a. sampling]

    b. slicing

    c. linearizing

    [✓ d. quantizing] ✓

    e. encoding

    f. multiplexing

15. A terminal LOCAL alarm lamp can be caused by which of the following?

    a. The distant transmitter not transmitting a proper framing pulse ✓

    b. The local transmitter not transmitting a proper framing pulse

    c. A defective distant receiver

    d. A defective local receiver ✓

    e. A defective outgoing repeatered line

    f. A defective incoming repeatered line ✓

16. The system will alarm on which of the following?

    [✓ a. Loss of power]

    b. Loss of a VF channel

    [✓ c. Prolonged absence of B2]

    d. Loss of a 12-channel group

    [✓ e. Absence of framing pulse]

17. Noise specification of 13dBRNC0 is measured in a properly aligned standard level 4 wire system as 19.9 PWC.

18. If the standard VTVM meter indicates a reading of -21dB at 75 ohm test point, what is the dBM value?

9

A. -21 dBM   C. -30 dBM
B. -18 dBM   [✓ D. -12 dBM]

19. Which unit would you replace first for the following alarm lamp indications?

Before looping - System alarm lamp lit
Remote alarm lamp lit

After looping - System alarm lamp lit
ACO lamp lit
Loop lamp lit
Remote alarm lamp lit
Local alarm lamp lit

XMT

20. Which unit would you replace next if the first one did not correct the problem?

Alarm

21. Which unit would you replace first for the following alarm lamp indications?

Before looping - System alarm lamp lit
Local alarm lamp lit

After looping - System alarm lamp lit
ACO lamp lit
Loop lamp lit
Local alarm lamp lit

RCV

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91A PCM CABLE CARRIER COURSE
ANSWER SHEET #4

1. What is the frequency of the interfering tone in a 91100 PCM Cable test set? 386KHZ

2. What are two advantages of two cable unidirectional repeater operations?

    1. Reduces cross talk at repeater housings
    2. 100% with unit or layer cable

3. If the system lights clear after looping the terminals during a system failure, what is the next probable cause?

    Failed repeater, bipolar converter
    Failure on the 9002A/B

4. How many miles may a repeater line extend?

    Not enough information

5. What is the probable causes of all channel units, receive level being approximately 6dB low?

    Short transmit gate at the distant terminal

6. What is the first step accomplished in a large office, when the office alarm bell and lights indicate a 9002A/B terminal has gone into alarm?

    Locate the terminal with system alarm lamp lit

7. Step 2 for above.

    Press ACO button to cut off office audiable alarms

8. Step 3 for above.

    Observe the alarm lamp indications and remember

9. Step 4 for above.

    Press loop button to loop the terminal

10. Step 5 for above.

    Observe the alarm lamp indications

11. Step 6 for above.

    Compare the alarm lamp indications

12. How many load coils may be used in a PCM Cable?

    None

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91A PCM CABLE CARRIER COURSE
PRACTICE EXERCISE #4

1. What is the frequency of the interfering tone in a 91100 PCM Cable test set? 272 KH

2. What are two advantages of two cable unidirectional repeater operations?

Less rept. ✓

3. If the system lights clear after looping the terminals during a system failure, what is the next probable cause?

Trouble out of office to other end

4. How many miles may a repeater line extend?

(1 mile or 6000 ft) 200 tandem

5. What is the probable causes of all channel units, receive level being approximately 6dB low? Wrong DB pads wired in ✓

6. What is the first step accomplished in a large office, when the office alarm bell and lights indicate a 9002A/B terminal has gone into alarm?

[illegible] of bell Loop sys.

7. Step 2 for above.

Check power

8. Step 3 for above.

Check [illegible]

9. Step 4 for above.

Check fuse

10. Step 5 for above.

Check power alarm card.

11. Step 6 for above.

12. How many load coils may be used in a PCM Cable?

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91A PCM CABLE CARRIER COURSE

PRACTICE EXERCISE #5

New cable has been installed in the field and the engineer requests that you re-establish the Simplex Loop Current to 60 ma. How do you strap the 91105 Simplex Power Unit?

The repeatered line now contains:

10 L238, 8 L239 repeater units and 9 miles of underground 19 gauge .083 mfd, PIC, D shield unfilled cable, and 6 miles of Aerial 24 gauge .083 mfd, PIC, D shield, unfilled cable, plus the office equipment.

50FT = 1mile

			40
a. 18.7	9 miles	47520(47.5K)	413
L239	121		1210
L238	132		1056
29.8	6 miles	316.80(31.7K)	941

3660
.40
3700

T-W, T-U ~~Swing~~ P-N = 260 ← = 3700
A-B, C-D, E-F, G-H = +130 & -130

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91A PCM CABLE CARRIER COURSE

ANSWER SHEET #5

New cable has been installed in the field and the engineer requests that you re-establish the Simplex Loop Current to 60 ma. How do you strap the 91105 Simplex Power Unit?

The repeatered line now contains:

10 L238, 8 L239 repeater units and 9 miles of underground 19 gauge .083 mfd, PIC, D shield unfilled cable, and 6 miles of Aerial 24 gauge .083 mfd, PIC, D shield, unfilled cable, plus the office equipment.

ANSWER: Reference GTEP 836-910-072,
Calculate total resistance:
1. Office repeater unit 91112, 2 ea. X 20 = 40
2. Line repeater L238, 10 ea. X 121 = 1210
   Line repeater L239, 8 ea. X 132 = 1056
3. 19 gauge cable = 8.7 X $\frac{9 \text{ X } 5280}{1000}$ = 8.7 X 47.5 = 413
   24 gauge cable = 29.8 X $\frac{6 \text{ X } 5280}{1000}$ = 29.8 X 31.7 = 944
4. Simplex unit 91105 2 X 10Ω Res + 2 X 2.5 fuses = 40
   TOTAL RESISTANCE: 3703

Reference Fig. 16 - 3
It will require 260 volts for a total of 4170 ohms.
Maximum Resistance: 4170
Total Loop Resistance: 3703
DIF RESISTANCE 467

Reference Fig. 16 - 6
400 to 500 Strap N-P, T-U, T-W, for 400 ohms.
Set variable adjustment for fine control.

Reference GTEP 342-910-105
Voltage required was 260 VDC
Note 1. +130V and -130V Strap A-B, C-D, E-F, G-H

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91A PCM CABLE CARRIER COURSE
PRACTICE EXERCISE #6

1. The transmit side of a 91112 office terminating repeater regenerates the pulse pattern. T____ F ✓

2. The crystal oscillator in a repeater operates at 1.544 MHz. T____ F ✓

3. The repeater output pulses are 6 volts base to peak. T____ F____

4. The noise induced in each cable section is accumulative throughout the system. T____ F____

5. Secondary lightning protection in a repeater drops simplex voltage. T ✓ F____

6. A PCM cable span can be fault tested with a standard DC cable tester. T____ F ✓

7. The 91111 repeater ~~amplifies~~ Regenerate the signal to a 6V P to P level. T____ F X

8. The 91112 repeater error detector detects at an error rate of 1 in 10^6. T____ F ✓

9. The repeater spare line transfer is actuated by grounding a transfer control lead on the failed repeater. T____ F ✓

10. How long after an 91112 office terminating repeater error detector detects the loss of PCM signal does it provide a ground out? .55

11. At a remote office, what connector and pins would you terminate the order wire pair on a 91101 shelf?

    27-29

12. The simplex power positive output is connected from pin 16 on connector J1, J3, J5, J7, J9 to pin 42 on connector J2-J4-J6-J8- J12 as required on Line Terminating Shelf.

13. What jumpers must be installed to loop the simplex power on a 91101 shelf at a intermediate office for working line 3 (position three)?

    J6-34 to J6-42

14. The maximum cable length distance in feet that the 9002B Channel Bank may be located from 91101 Line Terminating Shelf when a DSX-1 and GTS-8507 cable is used is 614 feet.

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91A PCM CABLE CARRIER COURSE
ANSWER SHEET #6

1. The transmit side of a 91112 office terminating repeater regenerates the pulse pattern. T______ F__X___

2. The crystal oscillator in a repeater operates at 1.544 MHz. T______ F__X___

3. The repeater output pulses are 6 volts base to peak. T______ F__X___

4. The noise induced in each cable section is accumulative throughout the system. T______ F__X___

5. Secondary lightning protection in a repeater drops simplex voltage. T__X___ F______

6. A PCM cable span can be fault tested with a standard DC cable tester. T______ F__X___

7. The 91111 repeater amplifies the signal to a 6V P to P level. T______ F__X___

8. The 91112 repeater error detector detects at an error rate of 1 in 10^6. T______ F__X___

9. The repeater spare line transfer is actuated by grounding a transfer control lead on the failed repeater. T______ F__X___

10. How long after an 91112 office terminating repeater error detector detects the loss of PCM signal does it provide a ground out?

    55 milliseconds

11. At a remote office, what connector and pins would you terminate the order wire pair on a 91101 shelf?

    J-12 Pins 27 and 29

12. The simplex power positive output is connected from pin ___16___ on connector ___J-1, J-3, J-5, J-7, J-9___ to pin ___42___ on connector ___J-2, J-4, J-6, J-8, J-10___ as required on Line Terminating Shelf.

13. What jumpers must be installed to loop the simplex power on a 91101 shelf at a intermediate office for working line 3 (position three)?

    J6 - 34 to J6 - 42

14. The maximum cable length distance in feet that the 9002B Channel Bank may be located from 91101 Line Terminating Shelf when a DSX-1 and GTS-8507 cable is used is ___614___ feet.

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91A PCM CABLE CARRIER COURSE
PRACTICE EXERCISE #8

1. What is the function of the Error Transfer Net. in the 91212-11 Office Repeater Unit?

2. The line repeaters of the 9148A system have been designed to operate over a cable attenuation range of __________ to ___________ dB.

3. What is the normal loop current required by the 9148A equipment?

4. Describe the line build out strapping for the 91212-XX if the 9 dB LBO network is not desired.

5. What is the difference between a 91213-01 and a 91213-02 bridging repeater unit?